UNIVERSAL MODULATOR

BACKGROUND

The present invention generally relates to cable television (CATV) and consumer video communication systems. More particularly, the invention relates to a dual-conversion universal modulator having programmable synthesized phase-locked loop oscillators driving their respective mixers which select a specific HI-IF frequency depending upon what output frequencies or standards are desired. Such standards include NTSC, PAL, NICAM, DIN, SECAM and any other known standard.

To allow reception of more than the 12 VHF channels on an older television receiver, most CATV systems require a settop terminal at a subscriber's location. Today, settop terminals not only provide a means for accepting a plurality of channels broadcast with varying bandwidths and guardbands for forward and reverse frequencies, but they also secure pay television services from unauthorized viewing. Other functions include decoding digital video and audio, interactive services, creating personalized viewer channels and the like.

In addition to the conversion from a cable transmission to a standard output frequency, a variety of descrambling techniques are employed depending upon the techniques used at a system headend. CATV equipment manufacturers are developing more sophisticated scrambling techniques using complicated encryption methods and digital processing to thwart pirating.

Most settop terminals are tunable. A block diagram for a prior art settop terminal is shown in **Figure 1**. Incoming signals from a CATV transmission network are coupled to an input bandpass amplifier and up-converted to a high intermediate frequency (HI-IF). The up-conversion requires a tunable local oscillator which selects a desired channel and an associated mixer. The mixer is coupled to a bandpass filter and down-converted to an IF channel using a fixed-frequency local oscillator and mixer. The output channel is filtered and forwarded to a subscriber's television receiver. Prior art settop terminals use one down-converter mixer with an oscillator having slight frequency agility to provide an output at one or two preselected channel frequencies. The output frequencies and bandwidths depend upon the transmission standard used.

In the United States, the NTSC (National Television System Committee) is the standard for color television. Other countries have chosen different systems. SECAM (*sequentiel couleur avec mémoire*) is used by France and Russia. PAL A and PAL B (phase alternation line) are used by many European countries such as Germany and the United Kingdom. Accordingly, television receivers are typically manufactured for a specific transmission standard. For worldwide use, a settop terminal must be adapted to the established broadcast standards.

Accordingly, there exists a need for an inexpensive method to adapt the output of a settop terminal to a variety of television broadcast standards.

SUMMARY

The present invention is a universal modulator that accepts baseband audio and video inputs and modulated audio or data and converts the combined signal to one of a plurality of frequencies in dependence upon a desired output frequency and broadcast standard. The universal modulator is located between baseband video and audio outputs of a settop terminal demodulator/decoder and an antenna input of a television receiver or other audio/video component (such as a VCR). The universal modulator includes a dual conversion architecture using an up-converter mixer and a down-converter mixer. Each mixer receives an oscillator input from a corresponding addressable, programmable, PLL (phase-locked loop) frequency synthesizer. Each PLL frequency is controlled by firmware in the settop terminal. Configuration is performed via manual input using settop terminal controls, or interrogation directly by the CATV headend or by programmed settings. A communication bus coupled to the firmware distributes addressable instructions to selectively control each PLL frequency and obviate oscillator difference beat frequencies (ODBFs) that may be manifested.

Accordingly, it is an object of the present invention to provide a universal modulator within a settop terminal which is able to couple a CATV transmission network to a customer's television receiver notwithstanding the broadcast standard used to transmit the television programs.

Other objects and advantages will become apparent to those skilled in this art after reading the detailed description of the preferred embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram of a prior art CATV settop terminal.

Figure 2 is a block diagram of a settop terminal incorporating the present invention.

Figure 3 is a block diagram of the preferred embodiment of the universal modulator of the present invention for use in a settop terminal.

Figure 4 is a block diagram of an addressable, programmable, phase-locked loop.

Figure 5 is a flow chart of the universal modulator configuring process.

Figure 6 is a flow chart of the ODBF translation process.

Figure 7 is a block diagram of a prior art headend.

Figure 8 is a block diagram of a headend made in accordance with the present invention.

Figures 9A and 9B are graphs of oscillator difference beat frequencies.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiment will be described with reference to the drawing figures where like numerals represent like elements throughout.

Figure 2 is a block diagram of a settop terminal **17** with the universal modulator **19** shown coupled to the output of a demodulator/decoder **21**. The demodulator/decoder **21** outputs a customer's channel selection as baseband audio **23** and video **25**. The functional description of the demodulator/decoder **21** is beyond the scope of the present invention **19** and shall not be described. An alternate audio source **27**, such as a NICAM carrier or modulated audio, may also be supplied and output **29**.

The higher quality baseband audio **23** and video **25** signals are available as settop terminal outputs **31**, **33** and may be coupled to television receivers that have baseband inputs. For television receivers that lack this feature, the universal modulator **19** provides an up-conversion output **35** compatible with the television broadcast standard used, from baseband to VHF or UHF for coupling to an antenna input.

The demodulator/decoder **17** outputs baseband audio **23** and video **25** and an alternate audio carrier **27** which differs from the baseband audio output. A reference clock signal **37** originating from a master oscillator and a common communication bus **39** are also coupled to the modulator **19**.

The universal modulator **19** is shown in more detail in **Figure 3**. The common communication bus **39** shown is an I^2C interface from Phillips® Electronics. Other bus communication protocols may alternatively be used. The configuration for a settop terminal **17** may be downloaded from the CATV system headend via a dedicated channel, or inband on the VBI of a channel. One skilled in this art would

appreciate that an advanced cable system can address and interrogate a specific settop terminal and alter its functionality. If the settop terminal has all configurations stored in firmware, the CATV system headend may simply instruct the settop terminal **17** of the standard being used. In this fashion, the settop terminal **17** does not require a technician to configure the unit but can auto-configure upon initial energization.

The communication bus protocol permits configuring component parameters to a particular broadcast standard using a unique addressing system within the settop terminal **17**. As shown in **Figure 3**, the I^2C bus **39** communicates with: a baseband audio programmable PLL frequency synthesizer **41**, a second audio carrier switched input **43**, adjustable amplifiers for the baseband video input **45** and baseband audio input **47**, a programmable PLL frequency synthesizer **49** for an up-converter mixer **91** and a programmable PLL frequency synthesizer **51** for a down-converter mixer **101**. Although third addressable programmable PLL **51** has been described as being coupled to a "down-converter" mixer **101**, the down-converter mixer **101** may in fact further up-convert the HI-IF signal to a higher frequency signal. It should be noted that each PLL frequency synthesizer **41**, **49**, **51** has an associated oscillator driver **L01**, **L02**, **L03** respectively (not shown). Each respective component has its own address to permit firmware contained parameters to be loaded for a given broadcast standard configuration.

The alternate audio input **53**, modulated by the demodulator/decoder **21**, is coupled to the solid state switch **43**. The output of the switch **43** is coupled to a first input **55** of a summing amplifier **57**. The baseband video input **59** is coupled to a clamp **61** which limits signal amplitude. The output from the clamp **61** is coupled to the video adjustable amplifier **45** where signal gain is increased or attenuated depending upon the broadcast standard. The output from the adjustable amplifier **45** is coupled to a hard limiter **63** which clips signal peaks. The output from the limiter **63** is coupled to a second input **65** of the summing amplifier **57**. The baseband audio input **67** is coupled to a baseband audio mixer **69** via an adjustable amplifier **68**. The baseband audio mixer **69** modulates the baseband to the broadcast standard. The baseband audio mixer **69** may be selectively activated or deactivated by the I^2C bus as required to support the standard in use. The output from the baseband audio mixer **69** is coupled to a lowpass filter **71** to remove RF. A second input to the audio lowpass filter **71** is provided as a modulated audio input **72**. The audio lowpass filter **71** is coupled to an audio adjustable amplifier **47** where signal gain is increased or attenuated. The audio adjustable amplifier **47** output is coupled to a third input **73** of the summing amplifier **57**.

Each of the mixers mix a signal input with the outputs of the three addressable, programmable PLL frequency synthesizers **41, 49, 51**. The PLL output frequencies vary depending on the broadcast standard and the RF output

frequency **105** desired. An addressable, programmable PLL frequency synthesizer **41, 49, 51** is shown in **Figure 4**.

The PLL **41, 49, 51** includes a phase detector **75**, a voltage-controlled oscillator (VCO) **77** and a loop filter **79**. The programmable PLL uses digital and analog techniques for frequency synthesis. The phase detector **75** compares two input frequencies **81a, 81b** and generates an output **83** that is a measure of their phase difference. If both inputs **81a, 81b** differ in frequency, the output is periodic at the difference frequency. If the frequency input does not equal the frequency output of the VCO **77**, the phase-error signal, after being filtered, causes the VCO frequency to deviate in the direction of the input frequency. When the frequencies match, the VCO **77** locks to the input frequency maintaining a fixed phase relationship with the input signal. The filtered output of the phase detector **75** is a dc signal. A modulo-*n* counter **87** is coupled between the VCO **77** output and the second input **81a** to the phase detector **75** to generate a multiple of the input reference frequency providing frequency synthesis.

Each PLL synthesizer **41, 49, 51** employed in the present invention **19** is addressable such that the input frequency can be adjusted by using an input modulo-*n* counter **89** or divide-by-*n* to adjust output frequency. Both the input frequency divide-by-*n* **89** and loop frequency divide-by-*n* **87** are addressable components. Each of the PLLs **41, 49, 51** are addressed and controlled in accordance with a predetermined

settop terminal **17** configuration. The configuration determines both the output frequency and operating bandwidth of the settop terminal **17** and adjusts the up- and down-converter PLLs **49, 51** accordingly.

Referring back to **Figure 3**, the summer amplifier **57** output is modulated with the frequency output from the second programmable PLL **49** to drive the up-conversion modulator **91** and translate the summed output to a high intermediate frequency (HI-IF) **93**. The HI-IF **93** is higher than the highest expected frequency in the summed amplifier **57** output bandwidth. In the present invention **19**, the input to the up-converter mixer **91** is not bandwidth limited.

The summing amplifier **57** output frequencies are translated to a new bandwidth, starting at a low frequency of the second PLL **49** minus the highest input band frequency, and ending at a high frequency of the third PLL **51** minus the lowest input band frequency. The second PLL **49** frequency is selected to translate the summing amplifier **57** output to correspond to the passband of an intermediate lowpass filter **95**. The output from the lowpass filter **95** is coupled to a buffer amplifier **97** to restore gain losses. The output from the buffer amplifier **97** is input to a final lowpass filter **99**. The buffer amplifier **97** maintains the system noise figure by overcoming the losses in the up-conversion mixer **91** and first HI-IF filter **95**. The signal is filtered by a HI-FI filter **99**, with the output coupled to a down-conversion mixer **101**. The third PLL synthesizer **51** is coupled to the down-conversion mixer **101**. The difference between the HI-IF **93**

and the third PLL **51** frequency is the desired output channel in the IF band. It should, however, be noted that the down-converter mixer **101** may accept the HI-IF **93** and further up-convert the signal to a higher frequency RF signal. The output is then filtered via a low pass filter **103**, (or other appropriate filter if up-converted), and forwarded as an RF output frequency **105** for reception by a television receiver.

As discussed above, the second **49** and third **51** programmable PLLs are controlled by the common communication bus **39**. The bus **39** is coupled to a processor in the settop terminal demodulator/decoder **21** which receives instructions from the system headend or from the settop terminal's **17** keypad. The configuration takes place transparently upon initial energization of the unit **17** if the system headend is equipped to send broadcast configuration instructions to the settop terminal **17**. If the system headend does not have this capability, the settop terminal **17** is configured via the keypad and function display (not shown). The configuration request, whether from the headend or at a consumer location, outputs the predetermined parameters onto the I^2C bus **39** for each of the addressable components. The predetermined parameters are related to the standard that is being employed by the CATV system on which the settop terminal **17** is located. These parameters will include the determination of whether a second audio carrier **53** exists, whether the baseband audio input **67** or the modulated audio input **72** are to be used and the frequency at which the RF output frequency **105** is desired. These parameters may also include any other

configurable parameters which are employed by any of the addressable components coupled to the communication bus **39**. It should also be recognized that since many of the components are addressable by the communication bus **39**, a user may manually input and address a particular component and selectively configure that component if desired.

An undesirable artifact of dual conversion is the generation of harmonics based on the fundamental oscillator frequencies. The harmonics of the second and third PLL frequency synthesizers **49, 51** mix with each other, thereby creating ODBFs. To obviate the intrusive effects of these PLL harmonics, the system and method of the present invention **19** eliminate this type of interference by translating the significant ODBFs out of the desired output channel.

A flowchart of the preferred method of the present invention **19** is shown in **Figure 5**. Upon making the necessary connections to the CATV cable **15** and subscriber's television receiver, the settop terminal **17** is energized **(step 201)** establishing communication with the system headend. If the cable system headend has forward communication ability **(step 205)**, the settop terminal is instructed how to configure itself for the applicable broadcast standard by downloading the parameters for the regional standards being used and the channel broadcast maps **(step 207)**. The predetermined PLL frequencies derived from the channel and broadcast maps in memory are converted into corresponding "divide-by" numbers for the PLL modulo-*n* converters **87, 89** and output to the second **49** and third **51** PLL frequency synthesizers. The

settop terminal **17** acknowledges when configuration is complete. If the cable system does not have forward communication capability, the user will be prompted to enter the applicable information via a display and keypad, thereby manually loading the applicable broadcast configuration **(step 209)**.

The settop terminal **19** reviews the loaded channel and broadcast maps. The predetermined frequencies are examined for potential ODBFs **(step 211)**. If it is determined that ODBF's are likely **(step 213)**, an ODBF translation is performed **(step 215)** as shown in **Figure 6** (which will be explained in greater detail hereafter). Otherwise, the original frequencies are maintained **(step 217)** (**Figure 5**). The frequencies are addressed to their respective PLL synthesizers as words over the I^2C communication bus **(step 219)**.

Referring to the flow diagram of **Figure 6**, the elimination of ODBFs is achieved by selectively adjusting the frequencies of the second **49** and third PLLs **51** to obtain the desired RF output frequency. For a typical NTSC signal, the up-converter mixer **91** modulates the input video **59** and audio signals **67** with the output **93** of the second PLL **49** to up-convert the input RF signal of the selected channel to the HI-IF **93 (step 301)**.

$$LO1 = \text{audio carrier frequency} \qquad \textbf{(Equation 1)}$$

$$LO2 = \text{HI-IF} \qquad \textbf{(Equation 2)}$$

The down-converter mixer mixes **101** the HI-IF **93** with the output of the third PLL synthesizer **51 (step 303)** to down-convert, (or further up-convert if desired), to obtain the desired RF output frequency **105**.

$$LO3 = (HI - IF) + RF\ output \qquad \textbf{(Equation 3)}$$

Multiples of the second and third PLL synthesizer **49, 51** fundamental frequencies define the even and odd harmonics,

$$m(LO2)\ and\ m(LO3),\ for\ m = 1, 2, 3, 4, \ldots \infty, \qquad \textbf{(Equation 4)}$$

which represent all possible harmonics **(step 305)**. However, due to the high system frequencies involved, examination of frequencies beyond the 10th harmonic is unnecessary.

The existence of an interfering ODBF is determined by serially calculating the differences between two harmonics of the second **49** and **51** third PLL synthesizers that are separated by at least one degree until the absolute value of an $ODBF_{m,n}$ is within a given bandwidth or a predetermined number of $ODBF_{m,n}$ values are calculated. When an $ODBF_{m,n}$ absolute value is found within the RF channel bandwidth, it is designated as an interfering oscillator difference beat frequency (ODBF). The general equation for calculating ODBFs is:

$$OBDF_{m,n} = (m + n)\ (LO2) - (m)(LO3),\ for\ m = 1, 2, 3, 4, \ldots 10,$$

(Equation 5)

with $n = 1$ for a first series, $n = 2$ for a second series, $n = 3$ for a third series, and so on up to $n = 8$ for all previously calculated harmonics **(step 305)**. The $ODBF_{m,n}$ calculated from the differing degrees of the second **49** and third PLL **51** harmonics are then examined **(step 307)**. For example, if the ODBF lies outside of the desired RF output channel bandwidth, no adjustment of the second **49** and third **51** PLL frequency synthesizers is required.

For an ODBF which falls inband, the following equations can be used to determine which direction the second **49** and third **51** PLL frequencies should be adjusted to translate the ODBF out of band. In these equations, CLB is the channel low-band; CMB is the channel mid-band; and CHB is the channel high-band.

If -CHB≤ODBF<-CMB; then HI-IF is moved downward. **(Equation 6A)**

(If the result of **Equation 5** is negative and the magnitude is greater than the mid-band of the desired RF output channel **(step 309)**, the HI-IF is moved downward **(step 311)**).

If -CMB≤ODBF≤-CLB; then HI-IF is moved upward. **(Equation 6B)**

(If the result of **Equation 5** is negative and the magnitude is less than or equal to the mid-band of the desired RF output channel **(step 313)**, the HI-IF is moved upward **(step 315)**).

If CLB≤ODBF≤CMB; then HI-IF is moved downward. **(Equation 6C)**

(If the result of **Equation 5** is positive and the magnitude is less or equal to than the mid-band of the desired RF output channel **(step 317)**, the HI-IF is moved downward **(step 319)**).

If CMB<ODBF≤CHB; then HI-IF is moved upward. **(Equation 6D)**

(If the result of **Equation 5** is positive and the magnitude is greater than the mid-band of the desired RF output channel **(step 321)**, the HI-IF is moved upward **(step 323)**).

The second **49** and third **51** PLLs are then adjusted **(step 327)** in accordance with the following: To translate the oscillator difference beats below or above the desired RF output channel, the following equation is used to determine the Δ in

frequency for the second **49** and third **51** PLL frequency synthesizers.

$$\Delta = \frac{CMB - [(m+n)(LO2) - m(LO3)]}{(m+n) - m} \quad \textbf{(Equation 7)}$$

The new second **49** and third **51** PLL frequencies (LO2' and LO3' respectively) are derived as shown in LO2' is calculated as shown in **Figure 6**.

The new PLL frequencies LO2' and LO3' translate the ODBFs above or below the desired RF output channel. The new PLL frequency values are used to program the second **49** and third **51** PLL frequency synthesizers **(step 327)**.

In an alternative embodiment, a fixed value for Δ can be used to simplify the calculations and the operation of the system. For example, a value of 4 MHz for Δ will suffice for NTSC and PAL systems.

The present invention will now be explained with reference to several examples. In the first example, if the HI-IF is 960 MHz and the desired RF output channel has a picture carrier frequency of 319.25 MHz, we have the following:

LO2 = HI-IF = 960 MHz; and **(from Equation 2)**

LO3 = HI-IF + RF output **(from Equation 3)**

= 960 + 319.25 = 1279.25 MHz.

The graph for ODBFs versus the RF output frequencies for m=2 and n=1 is shown in **Figure 9A**. If m=2 and n=1, then:

$$ODBF_{2,1}(960) = (m+n)(LO2) - m(LO3) \quad \textbf{(from Equation 5)}$$
$$= 3(960) - 2(1279.25)$$
$$= 2880 - 2558.5 = 321.5 \text{ MHz}$$

Since the desired RF output channel has a picture carrier frequency of 319.25 MHz (and assuming the bandwidth is 6 MHz for an NTSC channel), the ODBF is in-band for the desired RF output channel. From **Equation 6D**, since the ODBF is above the mid-band of the desired RF output channel, the HI-IF is moved upward. Assuming that Δ will be a fixed value of 4 MHz, LO2' will be 964 MHz and LO3' will be 1283.25 MHz. Accordingly, from **Equation 5**:

$$ODBF_{2,1}(964) = 3(964) - 2(964+319.25)$$
$$= 2892 - 2566.5 = 325.5 \text{ MHz}$$

The ODBF is now out of band.

In the second example, if the HI-IF is 960 MHz and the desired RF output channel has a picture carrier frequency of 481.25 MHz, we then have the following:

$$LO2 = \text{HI-IF} = 960 \text{ MHz; and} \quad \textbf{(from Equation 2)}$$

$$LO3 = \text{HI-IF} + \text{RF output} \quad \textbf{(from Equation 3)}$$
$$= 960 + 481.25 = 1441.25 \text{ MHz.}$$

The graph for ODBFs versus the RF output frequencies for m=3 and n=1 is shown in **Figure 9B**. If m=3 and n=1, the ODBF can be calculated as:

$$ODBF_{3,1}(960) = 4(960)-3(1441.25) \quad \textbf{(from Equation 5)}$$
$$= 3840-4323.75$$
$$= -483.75MHz.$$

Since the selected channel is 481.25 MHz, (and assuming an NTSC channel), the ODBF is in-band and the HI-IF must be relocated. The result of **Equation 5** for this example is negative and the magnitude is greater than the mid-band of the desired RF output channel (481.25 MHz). Accordingly, from **Equation 6A**, the HI-IF is moved lower. Assuming that Δ will be a fixed value of 4 MHz, LO2' will be 956 MHz and LO3' will be 1437.25 MHz. Recalculating the ODBF provides:

$$ODBF_{3,1}(956) = 4(956)-3(956+481.25 \quad \textbf{(from Equation 5)}$$
$$= 3824-4311.75 = -487.75 \text{ MHz}.$$

The ODBF is now out of band.

Due to the simple design of the present invention and since there are no shielding requirements to avoid ODBFs, the universal modulator may be incorporated onto a single integrated circuit. This was not possible with prior art signs.

Although the present invention has been described with reference to a settop terminal, it should be understood by

those of skill in the art that the invention is adaptable to other applications within the CATV environment, or even other communication applications which do not pertain to CATV systems.

For example, as shown in **Figure 7**, a prior art headend **700** generally includes two pieces of equipment; a baseband section **702** and an IF section **704**. These two sections **702**, **704** are typically designed to operate as "stand alone" units. Together, the two sections **702**, **704** output a single RF channel. The baseband section **702** generally comprises a video section **706** and an audio section **708**. These sections **706**, **708** receive audio and video baseband inputs and combine these inputs to an intermediate frequency for output to the IF section **704**. In the IF section **704**, the intermediate frequency is up-converted to the desired RF output channel. Since both sections **702**, **704** comprise units of equipment which are designed to work independently, this requires the duplication of many components between units **702**, **704**.

Referring to **Figure 8**, a headend **800** made in accordance with the present invention is shown. The headend **800** includes an audio pre-processing section **802**, a video pre-processing section **804**, the universal modulator **808** of the present invention (which is coupled to two filters **810**, **812**), a transmitter **814** (if desired), and a microprocessor **806**, which controls all of the components of the headend **800**. As was previously described hereinbefore, since the universal modulator **808** can convert a baseband input signal to any desired RF output signal while avoiding ODBFs, the universal

modulator **808** may be utilized to replace most of the components in the baseband section **702** and the IF section **704**. This significantly reduces the number of components required for a headend **800**. Accordingly, the cost and complexity are also thereby reduced.

It should be understood by those of skill in the art, with reference to **Figure 8**, that the universal modulator **808** of the present invention may also be used to accept a baseband digital VSB signal and remodulate the signal to a desired RF output signal for use with broadcast HDTV television receivers. The universal modulator **808** could also be used to transmit RF signals to devices which require high frequency RF signals, including wireless appliances such as a cordless telephone or a wireless LAN receiver. In such an application, the second mixer up-converts the HI-IF signal to a higher frequency RF signal, instead of down-converting the HI-IF as previously described. The desired RF output signal would be:

$$\text{RF output} = (\text{HI-IF}) + \text{LO3} \qquad \textbf{(Equation 10)}$$

The RF output signal may then be transmitted directly to the wireless appliance.

* * *

WE CLAIM:

1. A communication module which receives an input RF signal and converts said input RF signal to a desired RF output signal, the communication module comprising:

a first frequency agile local oscillator for generating a first frequency for mixing with said input RF signal to generate a high intermediate frequency (HI-IF) signal;

a second frequency agile local oscillator for generating a second frequency for mixing with said HI-IF signal to generate said desired RF output signal;

a controller including:

means for controlling said first and second frequency agile local oscillators to obtain said desired RF output signal;

means for comparing said first frequency with said second frequency to determine whether any interfering oscillator difference beat frequencies (ODBFs) exist within the bandwidth of said desired RF output signal; and

means for adjusting said first and second frequency agile local oscillators such that said first and second frequencies move said interfering ODBFs outside the bandwidth of said desired RF output signal.

2. The communication module of claim 1 wherein the communication module receives a plurality of input RF signals and said communication module further includes a signal

selector for selecting one of said plurality of input RF signals for mixing with said first frequency.

3. The communication module of claim 1 further comprising a transmitter, for wirelessly transmitting said RF output signal to a receiver.

4. The communication module of claim 3, whereby said transmitted signal is transmitted within the UHF or VHF frequency bands.

5. The communication module of claim 1, whereby the communication module is encompassed within a single integrated circuit.

6. The communication module of claim 1, whereby the communication module comprises an RF receiver circuit.

7. The communication module of claim 1, whereby the communication module comprises an RF transmitter circuit.

8. The communication module of claim 1 wherein said selected signal represents an analog signal transmission.

9. The communication module of claim 1 wherein said selected signal represents a digital signal transmission.

10. The communication module of claim 2 wherein said controller further comprises collateral memory storing a channel map of channels to predetermined channel carrier frequencies;

means for receiving a specific channel selection request and inputting said request to said microprocessor; and

said microprocessor determines said initial first local oscillator frequency.

11. A universal modulator for receiving a plurality of baseband input signals and outputting a desired RF output signal comprising:

a first PLL frequency synthesizer for generating a first frequency for mixing with a baseband audio signal to relocate said baseband audio signal within a desired bandwidth;

a second PLL frequency synthesizer for generating a second frequency for mixing with a summed signal within the desired bandwidth which includes said relocated baseband audio signal and a baseband video signal to produce a HI-IF signal;

a third PLL frequency synthesizer for generating a third frequency for mixing with said HI-IF signal to produce an RF output signal;

means for selecting said first, second and third PLL frequency synthesizers based upon said desired RF output signal including:

means for determining a first PLL frequency for said first synthesizer;

means for determining a second initial PLL frequency for said second synthesizer;

means for comparing said second initial PLL frequency with a third initial PLL frequency for said third synthesizer to determine whether any interfering oscillator difference beat frequencies exist within the bandwidth of said RF output signal; and

means for adjusting said second and third initial PLL frequencies to move any interfering ODBFs out of the bandwidth of said RF output signal.

12. A method for receiving an input RF signal and converts said input RF signal to a desired RF output signal, the method comprising:

generating a first frequency for mixing with said input RF signal to generate a high intermediate frequency (HI-IF) signal;

generating a second frequency for mixing with said HI-IF signal to generate said desired RF output signal;

controlling said first and second frequency agile local oscillators to obtain said desired RF output signal;

comparing said first frequency with said second frequency to determine whether any interfering oscillator difference beat frequencies (ODBFs) exist within the bandwidth of said desired RF output signal; and

adjusting said first and second frequency agile local oscillators such that said first and second frequencies move

said interfering ODBFs outside the bandwidth of said desired RF output signal.

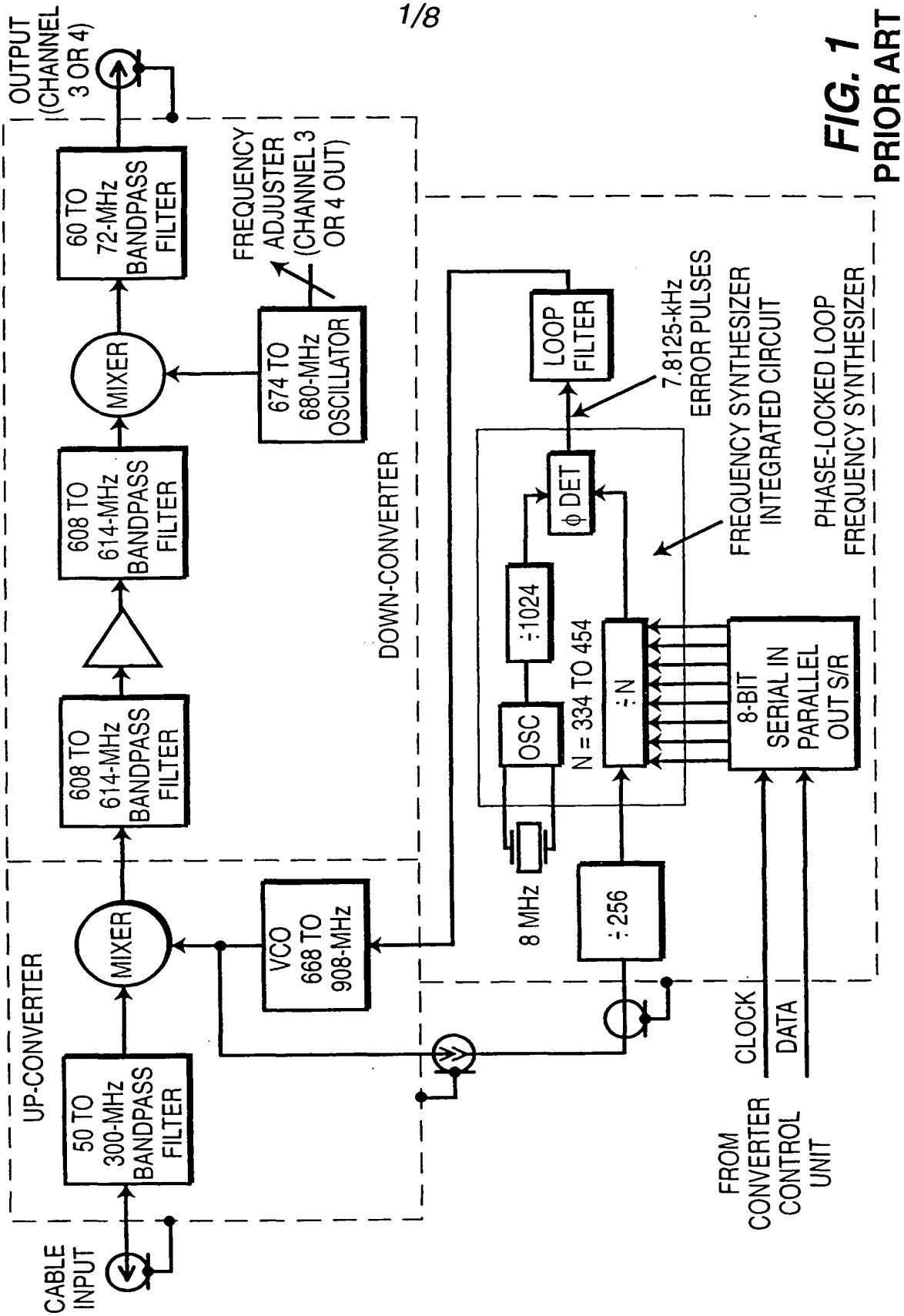


FIG. 1
PRIOR ART

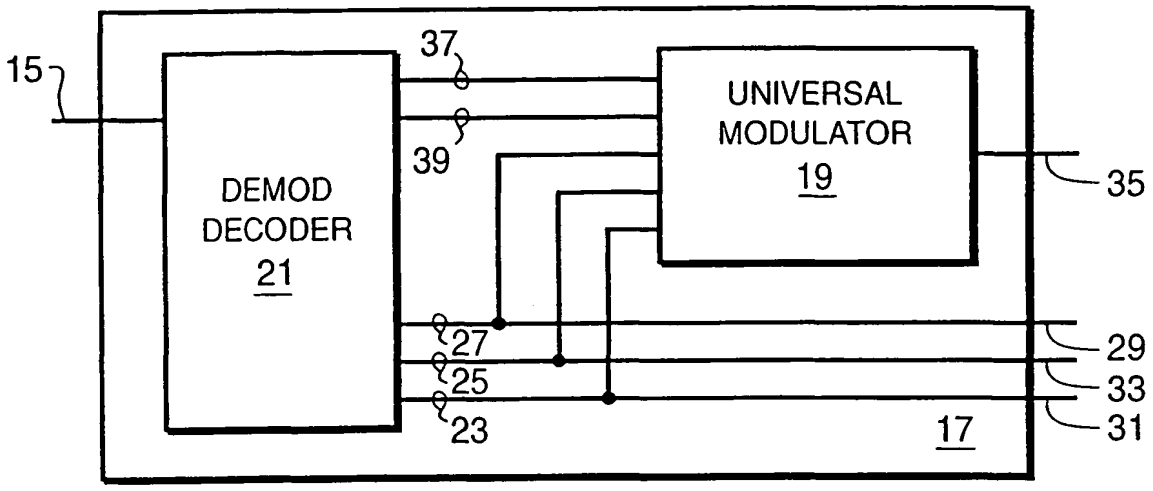

15
37
39
DEMOD
DECODER
21
UNIVERSAL
MODULATOR
19
35
27
25
23
29
33
31
17

FIG. 2

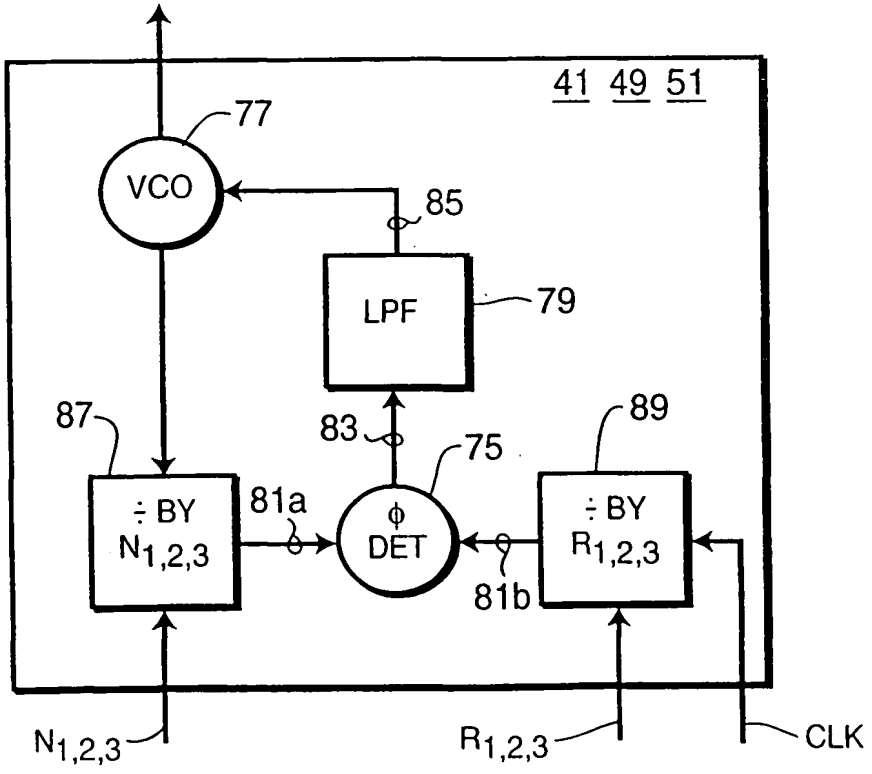

41 49 51
77
VCO
85
LPF
79
87
83
75
89
÷ BY
N1,2,3
81a
φ
DET
÷ BY
R1,2,3
81b
N1,2,3
R1,2,3
CLK

FIG. 4

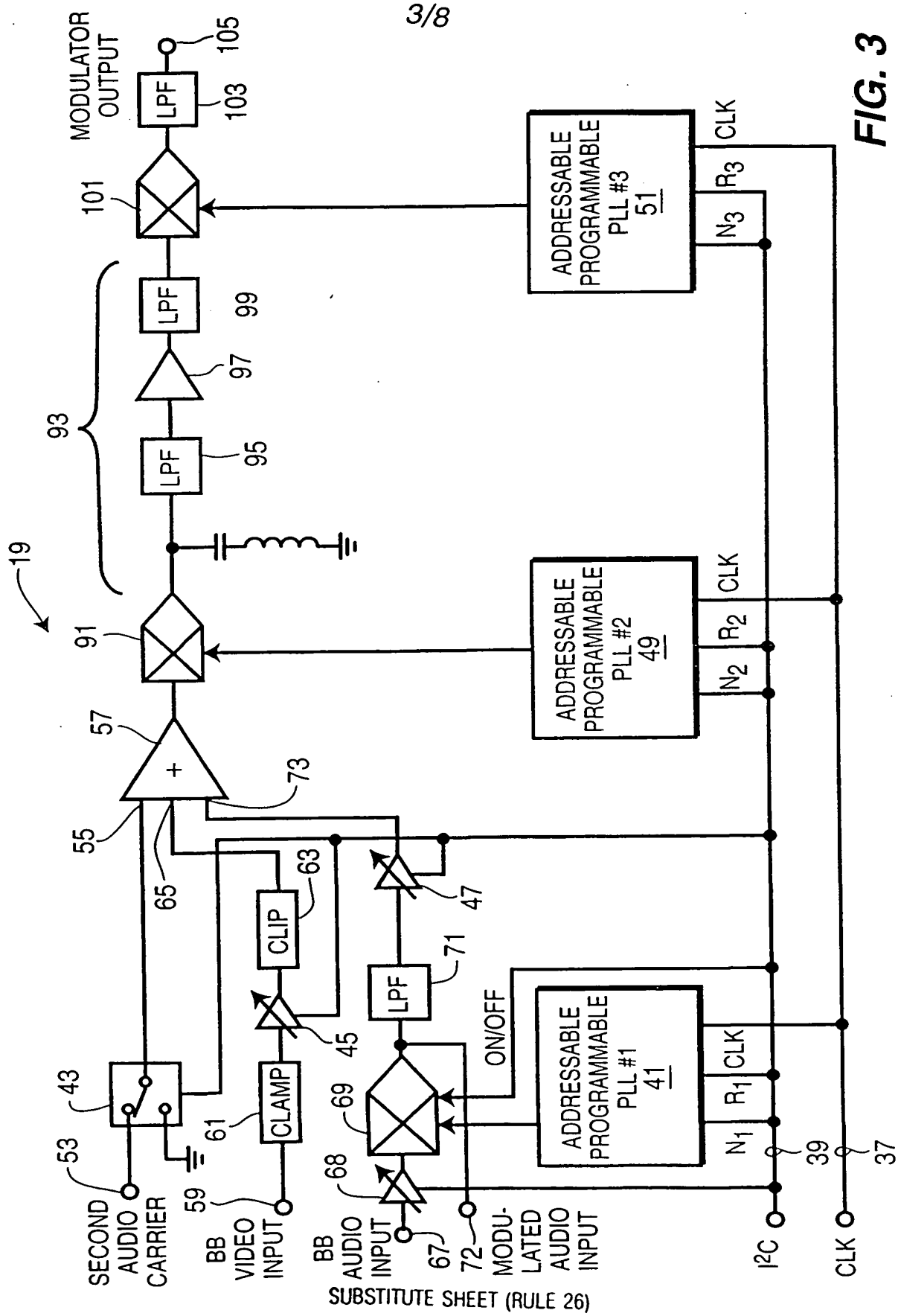

MODULATOR OUTPUT
105
LPF
103
101
LPF
99
97
93
LPF
95
19
91
57
+
73
55
65
63
CLIP
47
71
LPF
45
ON/OFF
43
69
CLAMP
61
53
68
59
67
72
SECOND AUDIO CARRIER
BB VIDEO INPUT
BB AUDIO INPUT
MODU-LATED AUDIO INPUT
ADDRESSABLE PROGRAMMABLE PLL #3 51
ADDRESSABLE PROGRAMMABLE PLL #2 49
ADDRESSABLE PROGRAMMABLE PLL #1 41
CLK
R_3
N_3
R_2
N_2
R_1
N_1
39
37
I^2C
CLK

FIG. 3

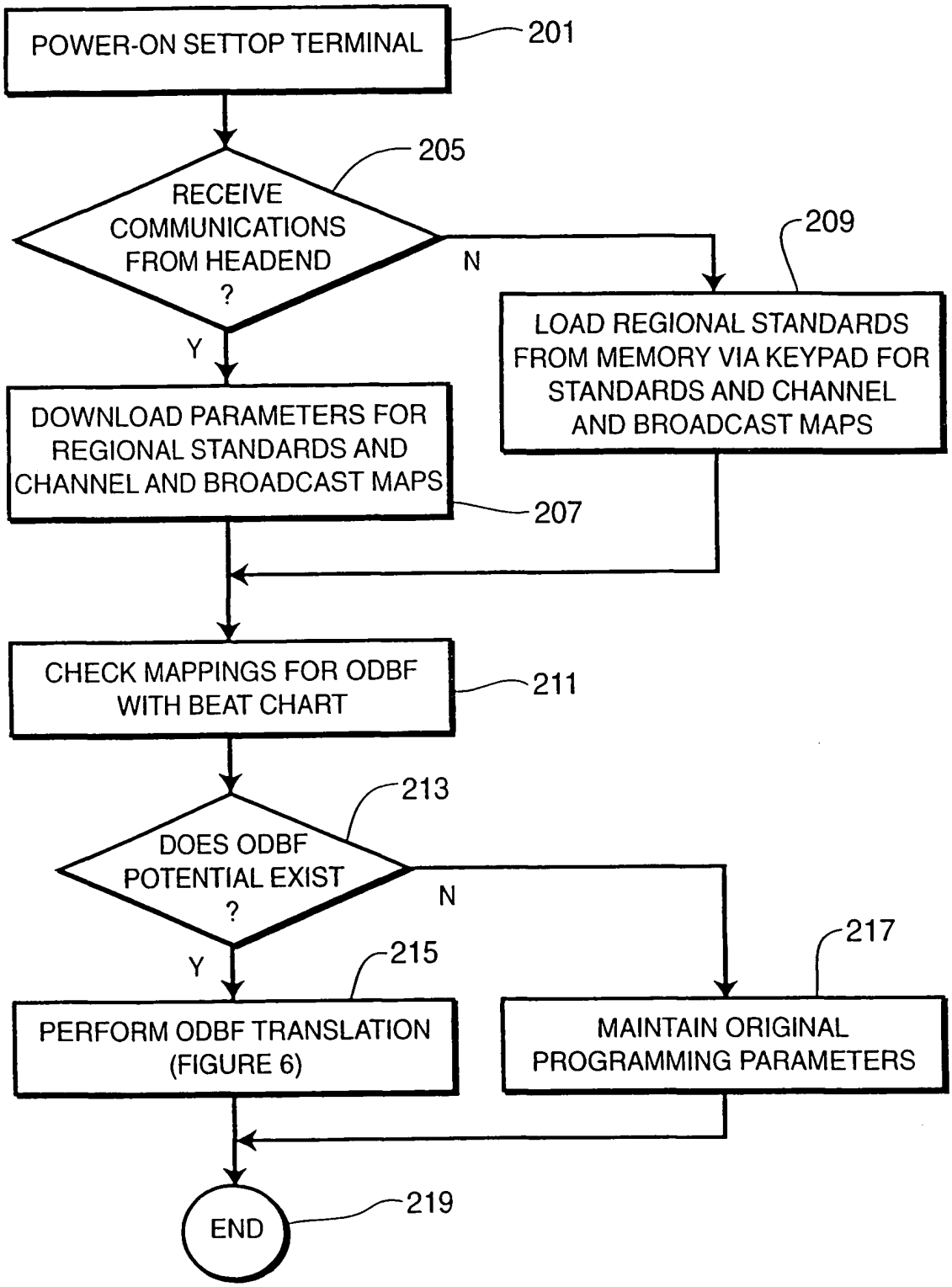

POWER-ON SETTOP TERMINAL
201
RECEIVE COMMUNICATIONS FROM HEADEND ?
205
N
209
Y
LOAD REGIONAL STANDARDS FROM MEMORY VIA KEYPAD FOR STANDARDS AND CHANNEL AND BROADCAST MAPS
DOWNLOAD PARAMETERS FOR REGIONAL STANDARDS AND CHANNEL AND BROADCAST MAPS
207
CHECK MAPPINGS FOR ODBF WITH BEAT CHART
211
DOES ODBF POTENTIAL EXIST ?
213
N
Y
215
217
PERFORM ODBF TRANSLATION (FIGURE 6)
MAINTAIN ORIGINAL PROGRAMMING PARAMETERS
END
219

FIG. 5

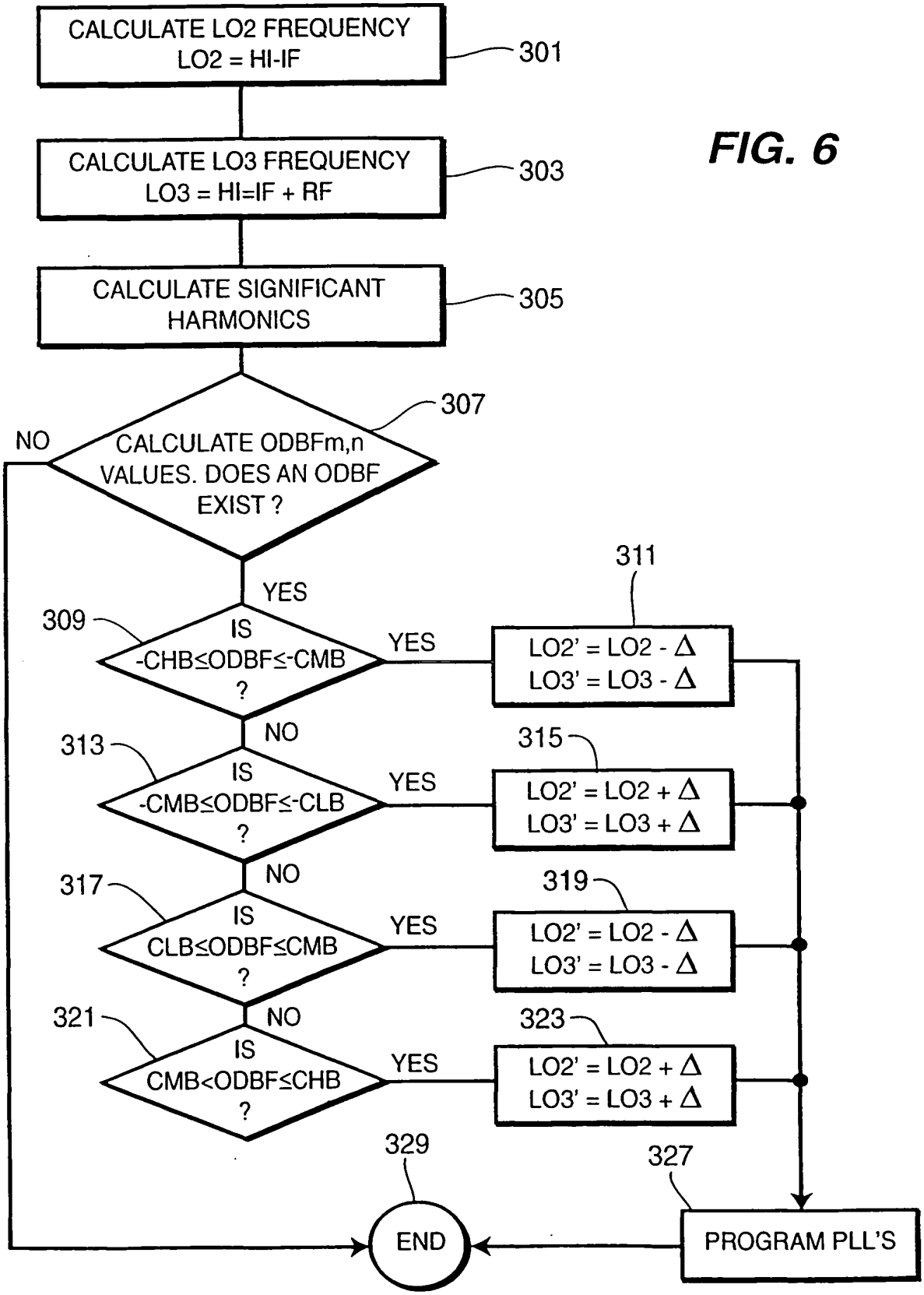

CALCULATE LO2 FREQUENCY
LO2 = HI-IF
301
CALCULATE LO3 FREQUENCY
LO3 = HI=IF + RF
303
CALCULATE SIGNIFICANT HARMONICS
305
307
CALCULATE ODBFm,n VALUES. DOES AN ODBF EXIST ?
NO
YES
309
IS -CHB≤ODBF≤-CMB ?
YES
311
LO2' = LO2 - Δ
LO3' = LO3 - Δ
NO
313
IS -CMB≤ODBF≤-CLB ?
YES
315
LO2' = LO2 + Δ
LO3' = LO3 + Δ
NO
317
IS CLB≤ODBF≤CMB ?
YES
319
LO2' = LO2 - Δ
LO3' = LO3 - Δ
NO
321
IS CMB<ODBF≤CHB ?
YES
323
LO2' = LO2 + Δ
LO3' = LO3 + Δ
329
END
327
PROGRAM PLL'S

FIG. 6

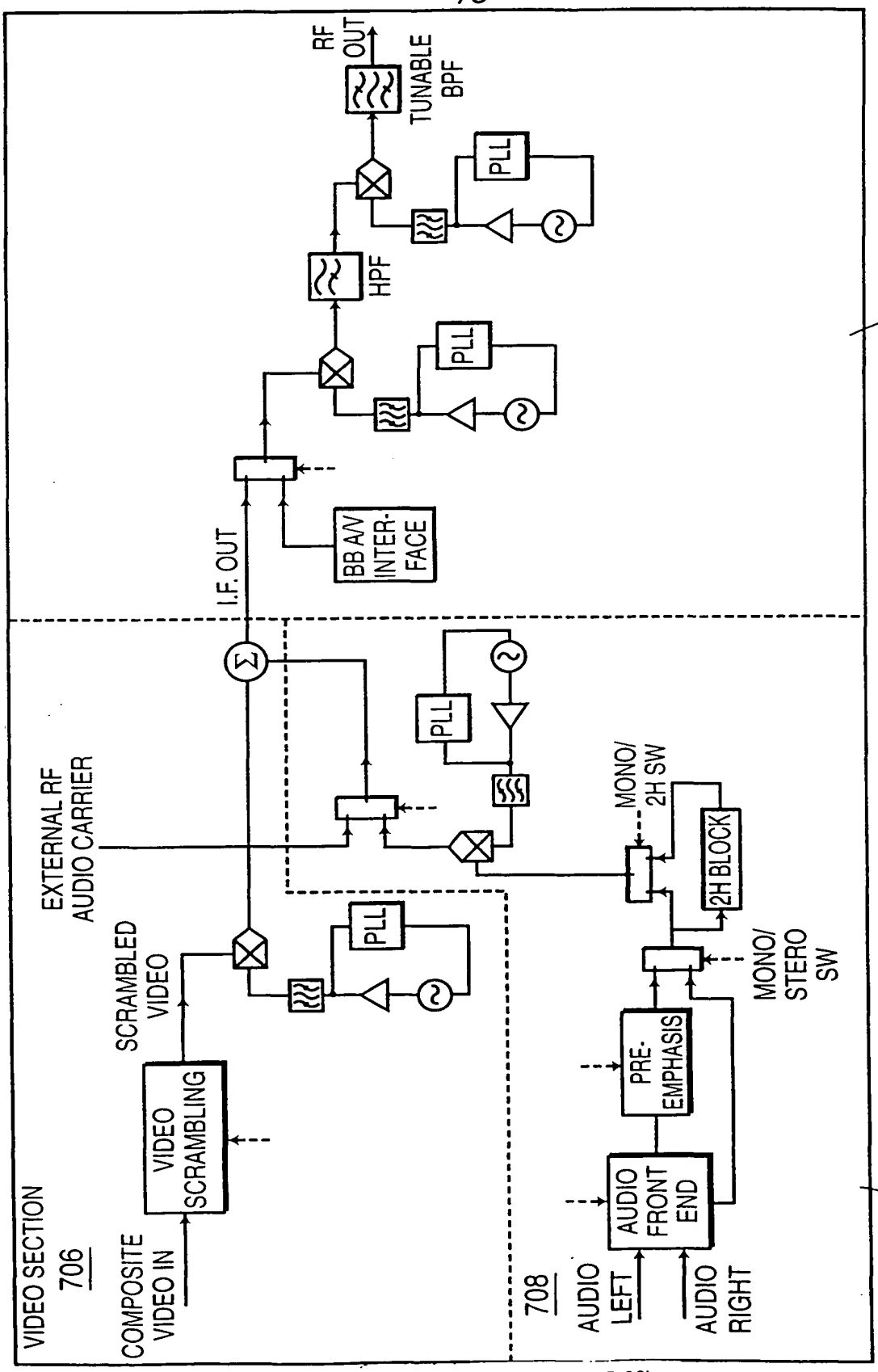


FIG. 7
PRIOR ART

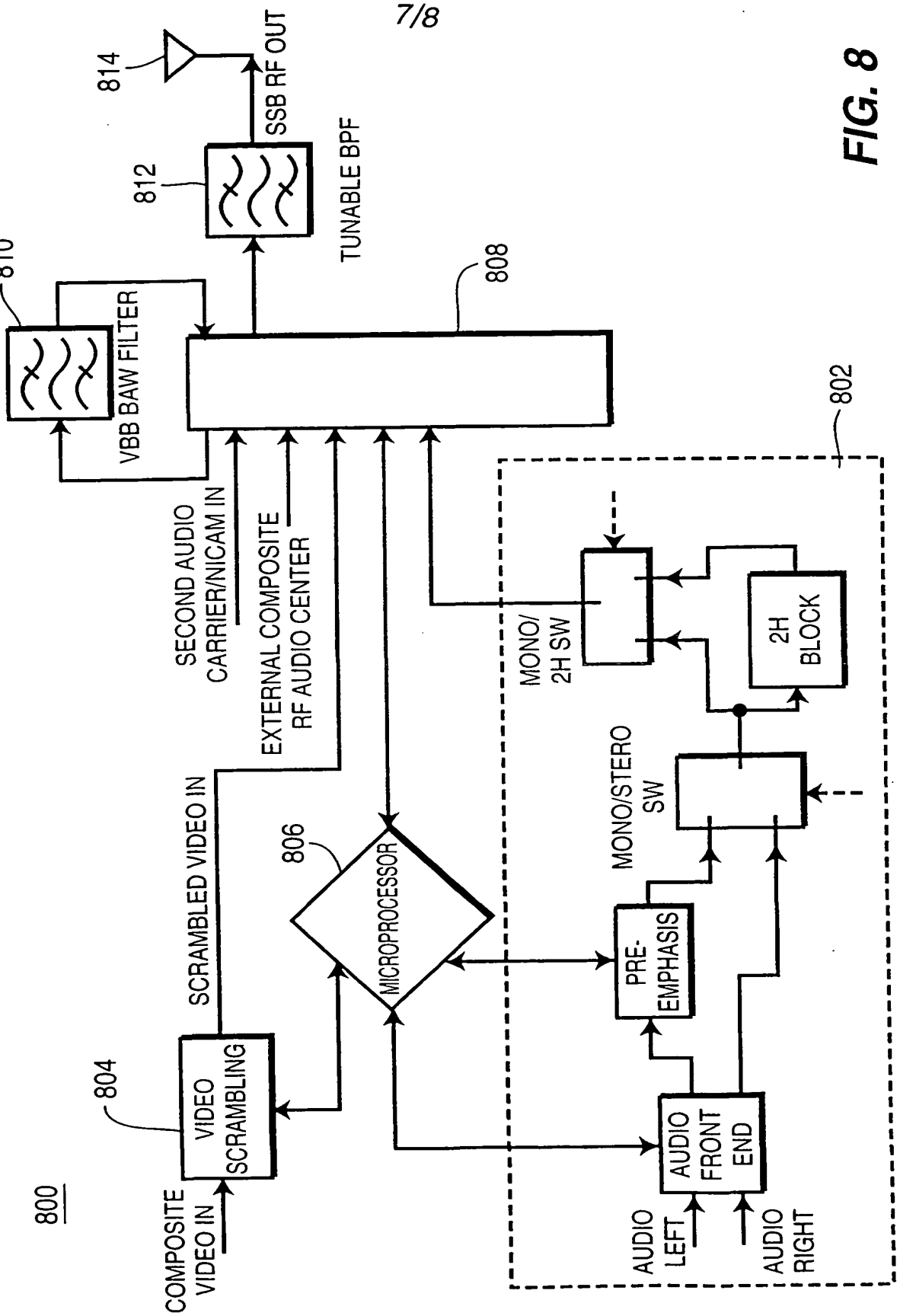

800
802
804
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808
810
812
814
COMPOSITE VIDEO IN
VIDEO SCRAMBLING
SCRAMBLED VIDEO IN
MICROPROCESSOR
EXTERNAL COMPOSITE RF AUDIO CENTER
SECOND AUDIO CARRIER/NICAM IN
VBB BAW FILTER
TUNABLE BPF
SSB RF OUT
AUDIO LEFT
AUDIO RIGHT
AUDIO FRONT END
PRE-EMPHASIS
MONO/STERO SW
MONO/ 2H SW
2H BLOCK

FIG. 8

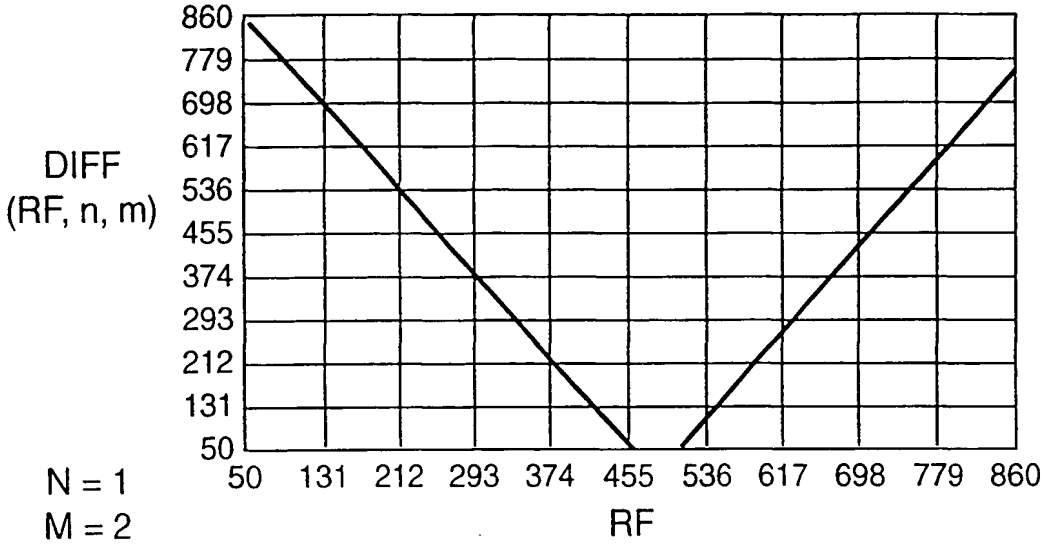

DIFF
(RF, n, m)
860
779
698
617
536
455
374
293
212
131
50
50 131 212 293 374 455 536 617 698 779 860
RF
N = 1
M = 2

FIG. 9A

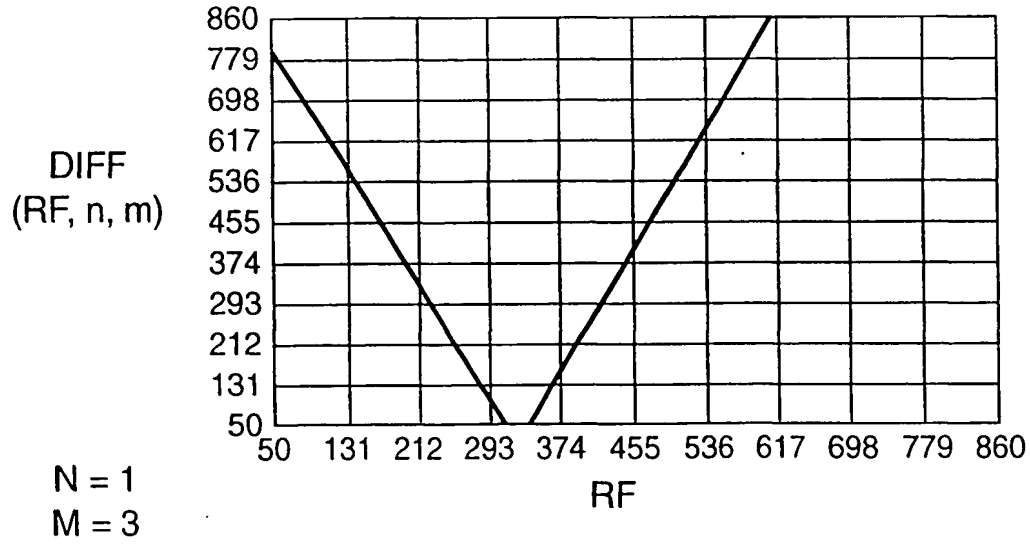

DIFF
(RF, n, m)
860
779
698
617
536
455
374
293
212
131
50
50 131 212 293 374 455 536 617 698 779 860
RF
N = 1
M = 3

FIG. 9B

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : H03D 7/16

A1

(11) International Publication Number: WO 00/33457

(43) International Publication Date: 8 June 2000 (08.06.00)

(21) International Application Number: PCT/US99/28232

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(30) Priority Data:
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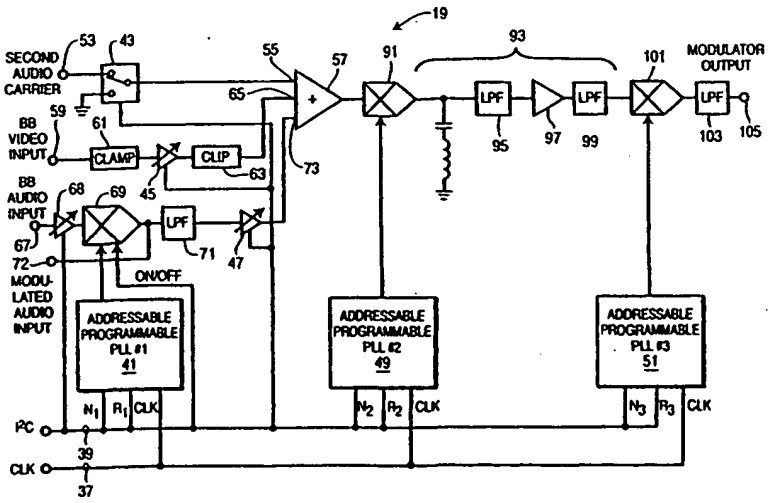
(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: WAIGHT, Matthew, G. [US/US]; 4982 E. Rolling Glen Drive, Pipersville, PA 18947 (US). PATEL, Dipakkumar, R. [US/US]; 227 E. Montgomery Avenue, Hatboro, PA 19040 (US).

(74) Agents: VOLPE, Anthony, S. et al.; Volpe and Koenig, P.C., 400 One Penn Center, 1617 John F. Kennedy Boulevard, Philadelphia, PA 19103 (US).

(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: UNIVERSAL MODULATOR



(57) Abstract

A universal modulator that accepts baseband audio and video inputs and converts the combined signal to one of a plurality of frequencies depending upon a desired output frequency and broadcast standard. The universal modulator is coupled between baseband video and audio outputs of a settop terminal demodulator/decoder and an input of a television receiver. Configuration of the universal modulator is performed via manual input by settop terminal controls or interrogation directly by a CATV headend. A communication bus coupled to the firmware distributes addressable instructions to selectively control addressable PLL frequency synthesizers. The modulator also obviates oscillator difference beat frequencies that may manifest themselves since programmable PLL frequency synthesizers are used.

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/28232

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H03D7/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H03D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 640 697 A (ORNDORFF DENNIS LEE) 17 June 1997 (1997-06-17) column 5, line 63 -column 6, line 59	1,11,12
X	DE 43 06 578 A (LOEWE OPTA GMBH) 8 September 1994 (1994-09-08) the whole document	1,12
A	WO 97 23034 A (WHITAKER CORP ;PRESCHUTTI JOSEPH P (US); FLICKINGER STEVEN LEE (US) 26 June 1997 (1997-06-26) page 4, line 28 -page 5, line 29	1,11,12
A	US 5 038 404 A (MARZ DANIEL) 6 August 1991 (1991-08-06) column 1, line 57 -column 5, line 68	1,11,12

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Date of the actual completion of the international search	Date of mailing of the international search report
13 March 2000	23/03/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Peeters, M

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Inte l Application No
PCT/US 99/28232

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 84 04637 A (MOTOROLA INC) 22 November 1984 (1984-11-22)	

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 99/28232

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5640697 A	17-06-1997	US 5493210 A	20-02-1996
		US 5633582 A	27-05-1997
DE 4306578 A	08-09-1994	NONE	
WO 9723034 A	26-06-1997	AU 1421297 A	14-07-1997
		EP 0868775 A	07-10-1998
US 5038404 A	06-08-1991	NONE	
WO 8404637 A	22-11-1984	US 4512035 A	16-04-1985
		US 4551856 A	05-11-1985
		AT 48054 T	15-12-1989
		AU 562869 B	18-06-1987
		AU 3012784 A	04-12-1984
		CA 1221741 A	12-05-1987
		CA 1224530 C	21-07-1987
		DK 18385 A,B,	15-03-1985
		EP 0144394 A	19-06-1985
		FI 850167 A,B,	15-01-1985
		HK 17192 A	13-03-1992
		JP 60501338 T	15-08-1985
		NO 850159 A	15-01-1985
		SG 4592 G	20-03-1992

TENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
GIC-PT080PC		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US 99/ 28232	30/11/1999	30/11/1998
Applicant		
GENERAL INSTRUMENT CORPORATION et al		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

 a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

 [] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

 b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

 [] contained in the international application in written form.

 [] filed together with the international application in computer readable form.

 [] furnished subsequently to this Authority in written form.

 [] furnished subsequently to this Authority in computer readble form.

 [] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

 [] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [] **Certain claims were found unsearchable** (See Box I).

3. [] **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,

 [X] the text is approved as submitted by the applicant.

 [] the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

 [X] the text is approved as submitted by the applicant.

 [] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 3

 [X] as suggested by the applicant.

 [] because the applicant failed to suggest a figure.

 [] because this figure better characterizes the invention.

 [] None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No
[redacted]/US 99/28232

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H03D7/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H03D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

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Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

International Application No
[redacted]/US 99/28232

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INTERNATIONAL SEARCH REPORT

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US 5640697 A	17-06-1997	US 5493210 A	20-02-1996
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DE 4306578 A	08-09-1994	NONE	
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International application No. PCT/US99/28232	**Applicant's or agent's file reference** GIC-PT080PC
International filing date (day/month/year) 30 November 1999 (30.11.99)	**Priority date** (day/month/year) 30 November 1998 (30.11.98)
Applicant WAIGHT, Matthew, G. et al	

1. The designated Office is hereby notified of its election made:

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26 June 2000 (26.06.00)

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(51) International Patent Classification 7 : H03D 7/16

A1

(11) International Publication Number: **WO 00/33457**

(43) International Publication Date: 8 June 2000 (08.06.00)

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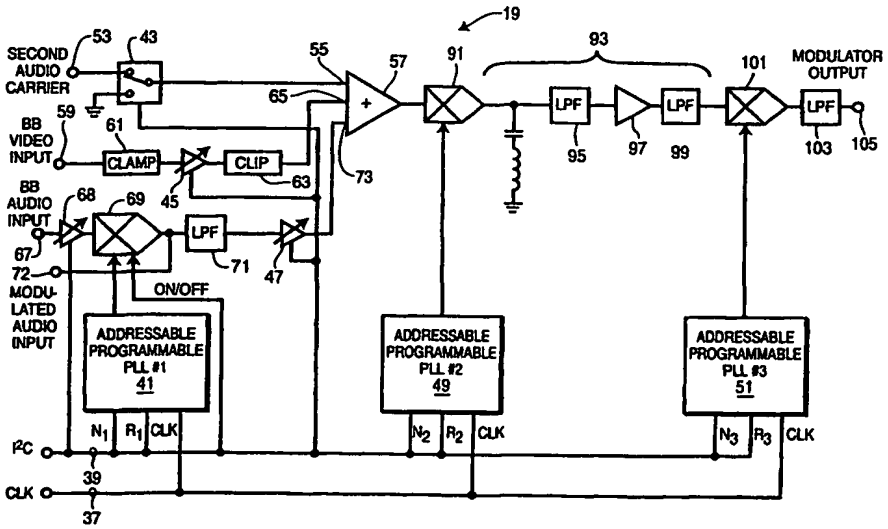
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(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.

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BA	Bosnia and Herzegovina	**GE**	Georgia	**MD**	Republic of Moldova	**TG**	Togo
BB	Barbados	**GH**	Ghana	**MG**	Madagascar	**TJ**	Tajikistan
BE	Belgium	**GN**	Guinea	**MK**	The former Yugoslav Republic of Macedonia	**TM**	Turkmenistan
BF	Burkina Faso	**GR**	Greece			**TR**	Turkey
BG	Bulgaria	**HU**	Hungary	**ML**	Mali	**TT**	Trinidad and Tobago
BJ	Benin	**IE**	Ireland	**MN**	Mongolia	**UA**	Ukraine
BR	Brazil	**IL**	Israel	**MR**	Mauritania	**UG**	Uganda
BY	Belarus	**IS**	Iceland	**MW**	Malawi	**US**	United States of America
CA	Canada	**IT**	Italy	**MX**	Mexico	**UZ**	Uzbekistan
CF	Central African Republic	**JP**	Japan	**NE**	Niger	**VN**	Viet Nam
CG	Congo	**KE**	Kenya	**NL**	Netherlands	**YU**	Yugoslavia
CH	Switzerland	**KG**	Kyrgyzstan	**NO**	Norway	**ZW**	Zimbabwe
CI	Côte d'Ivoire	**KP**	Democratic People's Republic of Korea	**NZ**	New Zealand		
CM	Cameroon			**PL**	Poland		
CN	China	**KR**	Republic of Korea	**PT**	Portugal		
CU	Cuba	**KZ**	Kazakstan	**RO**	Romania		
CZ	Czech Republic	**LC**	Saint Lucia	**RU**	Russian Federation		
DE	Germany	**LI**	Liechtenstein	**SD**	Sudan		
DK	Denmark	**LK**	Sri Lanka	**SE**	Sweden		
EE	Estonia	**LR**	Liberia	**SG**	Singapore		

UNIVERSAL MODULATOR

BACKGROUND

The present invention generally relates to cable television (CATV) and consumer video communication systems. More particularly, the invention relates to a dual-conversion universal modulator having programmable synthesized phase-locked loop oscillators driving their respective mixers which select a specific HI-IF frequency depending upon what output frequencies or standards are desired. Such standards include NTSC, PAL, NICAM, DIN, SECAM and any other known standard.

To allow reception of more than the 12 VHF channels on an older television receiver, most CATV systems require a settop terminal at a subscriber's location. Today, settop terminals not only provide a means for accepting a plurality of channels broadcast with varying bandwidths and guardbands for forward and reverse frequencies, but they also secure pay television services from unauthorized viewing. Other functions include decoding digital video and audio, interactive services, creating personalized viewer channels and the like.

In addition to the conversion from a cable transmission to a standard output frequency, a variety of descrambling techniques are employed depending upon the techniques used at a system headend. CATV equipment manufacturers are developing more sophisticated scrambling techniques using complicated encryption methods and digital processing to thwart pirating.

Most settop terminals are tunable. A block diagram for a prior art settop terminal is shown in **Figure 1**. Incoming signals from a CATV transmission network are coupled to an input bandpass amplifier and up-converted to a high intermediate frequency (HI-IF). The up-conversion requires a tunable local oscillator which selects a desired channel and an associated mixer. The mixer is coupled to a bandpass filter and down-converted to an IF channel using a fixed-frequency local oscillator and mixer. The output channel is filtered and forwarded to a subscriber's television receiver. Prior art settop terminals use one down-converter mixer with an oscillator having slight frequency agility to provide an output at one or two preselected channel frequencies. The output frequencies and bandwidths depend upon the transmission standard used.

In the United States, the NTSC (National Television System Committee) is the standard for color television. Other countries have chosen different systems. SECAM (*sequentiel couleur avec mémoire*) is used by France and Russia. PAL A and PAL B (phase alternation line) are used by many European countries such as Germany and the United Kingdom. Accordingly, television receivers are typically manufactured for a specific transmission standard. For worldwide use, a settop terminal must be adapted to the established broadcast standards.

Accordingly, there exists a need for an inexpensive method to adapt the output of a settop terminal to a variety of television broadcast standards.

SUMMARY

The present invention is a universal modulator that accepts baseband audio and video inputs and modulated audio or data and converts the combined signal to one of a plurality of frequencies in dependence upon a desired output frequency and broadcast standard. The universal modulator is located between baseband video and audio outputs of a settop terminal demodulator/decoder and an antenna input of a television receiver or other audio/video component (such as a VCR). The universal modulator includes a dual conversion architecture using an up-converter mixer and a down-converter mixer. Each mixer receives an oscillator input from a corresponding addressable, programmable, PLL (phase-locked loop) frequency synthesizer. Each PLL frequency is controlled by firmware in the settop terminal. Configuration is performed via manual input using settop terminal controls, or interrogation directly by the CATV headend or by programmed settings. A communication bus coupled to the firmware distributes addressable instructions to selectively control each PLL frequency and obviate oscillator difference beat frequencies (ODBFs) that may be manifested.

Accordingly, it is an object of the present invention to provide a universal modulator within a settop terminal which is able to couple a CATV transmission network to a customer's television receiver notwithstanding the broadcast standard used to transmit the television programs.

Other objects and advantages will become apparent to those skilled in this art after reading the detailed description of the preferred embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram of a prior art CATV settop terminal.

Figure 2 is a block diagram of a settop terminal incorporating the present invention.

Figure 3 is a block diagram of the preferred embodiment of the universal modulator of the present invention for use in a settop terminal.

Figure 4 is a block diagram of an addressable, programmable, phase-locked loop.

Figure 5 is a flow chart of the universal modulator configuring process.

Figure 6 is a flow chart of the ODBF translation process.

Figure 7 is a block diagram of a prior art headend.

Figure 8 is a block diagram of a headend made in accordance with the present invention.

Figures 9A and 9B are graphs of oscillator difference beat frequencies.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiment will be described with reference to the drawing figures where like numerals represent like elements throughout.

Figure 2 is a block diagram of a settop terminal **17** with the universal modulator **19** shown coupled to the output of a demodulator/decoder **21**. The demodulator/decoder **21** outputs a customer's channel selection as baseband audio **23** and video **25**. The functional description of the demodulator/decoder **21** is beyond the scope of the present invention **19** and shall not be described. An alternate audio source **27**, such as a NICAM carrier or modulated audio, may also be supplied and output **29**.

The higher quality baseband audio **23** and video **25** signals are available as settop terminal outputs **31**, **33** and may be coupled to television receivers that have baseband inputs. For television receivers that lack this feature, the universal modulator **19** provides an up-conversion output **35** compatible with the television broadcast standard used, from baseband to VHF or UHF for coupling to an antenna input.

The demodulator/decoder **17** outputs baseband audio **23** and video **25** and an alternate audio carrier **27** which differs from the baseband audio output. A reference clock signal **37** originating from a master oscillator and a common communication bus **39** are also coupled to the modulator **19**.

The universal modulator **19** is shown in more detail in **Figure 3**. The common communication bus **39** shown is an I^2C interface from Phillips® Electronics. Other bus communication protocols may alternatively be used. The configuration for a settop terminal **17** may be downloaded from the CATV system headend via a dedicated channel, or inband on the VBI of a channel. One skilled in this art would

appreciate that an advanced cable system can address and interrogate a specific settop terminal and alter its functionality. If the settop terminal has all configurations stored in firmware, the CATV system headend may simply instruct the settop terminal **17** of the standard being used. In this fashion, the settop terminal **17** does not require a technician to configure the unit but can auto-configure upon initial energization.

The communication bus protocol permits configuring component parameters to a particular broadcast standard using a unique addressing system within the settop terminal **17**. As shown in **Figure 3**, the I^2C bus **39** communicates with: a baseband audio programmable PLL frequency synthesizer **41**, a second audio carrier switched input **43**, adjustable amplifiers for the baseband video input **45** and baseband audio input **47**, a programmable PLL frequency synthesizer **49** for an up-converter mixer **91** and a programmable PLL frequency synthesizer **51** for a down-converter mixer **101**. Although third addressable programmable PLL **51** has been described as being coupled to a "down-converter" mixer **101**, the down-converter mixer **101** may in fact further up-convert the HI-IF signal to a higher frequency signal. It should be noted that each PLL frequency synthesizer **41**, **49**, **51** has an associated oscillator driver **L01**, **L02**, **L03** respectively (not shown). Each respective component has its own address to permit firmware contained parameters to be loaded for a given broadcast standard configuration.

The alternate audio input **53**, modulated by the demodulator/decoder **21**, is coupled to the solid state switch **43**. The output of the switch **43** is coupled to a first input **55** of a summing amplifier **57**. The baseband video input **59** is coupled to a clamp **61** which limits signal amplitude. The output from the clamp **61** is coupled to the video adjustable amplifier **45** where signal gain is increased or attenuated depending upon the broadcast standard. The output from the adjustable amplifier **45** is coupled to a hard limiter **63** which clips signal peaks. The output from the limiter **63** is coupled to a second input **65** of the summing amplifier **57**. The baseband audio input **67** is coupled to a baseband audio mixer **69** via an adjustable amplifier **68**. The baseband audio mixer **69** modulates the baseband to the broadcast standard. The baseband audio mixer **69** may be selectively activated or deactivated by the I^2C bus as required to support the standard in use. The output from the baseband audio mixer **69** is coupled to a lowpass filter **71** to remove RF. A second input to the audio lowpass filter **71** is provided as a modulated audio input **72**. The audio lowpass filter **71** is coupled to an audio adjustable amplifier **47** where signal gain is increased or attenuated. The audio adjustable amplifier **47** output is coupled to a third input **73** of the summing amplifier **57**.

Each of the mixers mix a signal input with the outputs of the three addressable, programmable PLL frequency synthesizers **41**, **49**, **51**. The PLL output frequencies vary depending on the broadcast standard and the RF output

frequency **105** desired. An addressable, programmable PLL frequency synthesizer **41**, **49**, **51** is shown in **Figure 4**.

The PLL **41**, **49**, **51** includes a phase detector **75**, a voltage-controlled oscillator (VCO) **77** and a loop filter **79**. The programmable PLL uses digital and analog techniques for frequency synthesis. The phase detector **75** compares two input frequencies **81a**, **81b** and generates an output **83** that is a measure of their phase difference. If both inputs **81a**, **81b** differ in frequency, the output is periodic at the difference frequency. If the frequency input does not equal the frequency output of the VCO **77**, the phase-error signal, after being filtered, causes the VCO frequency to deviate in the direction of the input frequency. When the frequencies match, the VCO **77** locks to the input frequency maintaining a fixed phase relationship with the input signal. The filtered output of the phase detector **75** is a dc signal. A modulo-*n* counter **87** is coupled between the VCO **77** output and the second input **81a** to the phase detector **75** to generate a multiple of the input reference frequency providing frequency synthesis.

Each PLL synthesizer **41**, **49**, **51** employed in the present invention **19** is addressable such that the input frequency can be adjusted by using an input modulo-*n* counter **89** or divide-by-*n* to adjust output frequency. Both the input frequency divide-by-*n* **89** and loop frequency divide-by-*n* **87** are addressable components. Each of the PLLs **41**, **49**, **51** are addressed and controlled in accordance with a predetermined

settop terminal **17** configuration. The configuration determines both the output frequency and operating bandwidth of the settop terminal **17** and adjusts the up- and down-converter PLLs **49, 51** accordingly.

Referring back to **Figure 3**, the summer amplifier **57** output is modulated with the frequency output from the second programmable PLL **49** to drive the up-conversion modulator **91** and translate the summed output to a high intermediate frequency (HI-IF) **93**. The HI-IF **93** is higher than the highest expected frequency in the summed amplifier **57** output bandwidth. In the present invention **19**, the input to the up-converter mixer **91** is not bandwidth limited.

The summing amplifier **57** output frequencies are translated to a new bandwidth, starting at a low frequency of the second PLL **49** minus the highest input band frequency, and ending at a high frequency of the third PLL **51** minus the lowest input band frequency. The second PLL **49** frequency is selected to translate the summing amplifier **57** output to correspond to the passband of an intermediate lowpass filter **95**. The output from the lowpass filter **95** is coupled to a buffer amplifier **97** to restore gain losses. The output from the buffer amplifier **97** is input to a final lowpass filter **99**. The buffer amplifier **97** maintains the system noise figure by overcoming the losses in the up-conversion mixer **91** and first HI-IF filter **95**. The signal is filtered by a HI-FI filter **99**, with the output coupled to a down-conversion mixer **101**. The third PLL synthesizer **51** is coupled to the down-conversion mixer **101**. The difference between the HI-IF **93**

and the third PLL **51** frequency is the desired output channel in the IF band. It should, however, be noted that the down-converter mixer **101** may accept the HI-IF **93** and further up-convert the signal to a higher frequency RF signal. The output is then filtered via a low pass filter **103**, (or other appropriate filter if up-converted), and forwarded as an RF output frequency **105** for reception by a television receiver.

As discussed above, the second **49** and third **51** programmable PLLs are controlled by the common communication bus **39**. The bus **39** is coupled to a processor in the settop terminal demodulator/decoder **21** which receives instructions from the system headend or from the settop terminal's **17** keypad. The configuration takes place transparently upon initial energization of the unit **17** if the system headend is equipped to send broadcast configuration instructions to the settop terminal **17**. If the system headend does not have this capability, the settop terminal **17** is configured via the keypad and function display (not shown). The configuration request, whether from the headend or at a consumer location, outputs the predetermined parameters onto the I^2C bus **39** for each of the addressable components. The predetermined parameters are related to the standard that is being employed by the CATV system on which the settop terminal **17** is located. These parameters will include the determination of whether a second audio carrier **53** exists, whether the baseband audio input **67** or the modulated audio input **72** are to be used and the frequency at which the RF output frequency **105** is desired. These parameters may also include any other

configurable parameters which are employed by any of the addressable components coupled to the communication bus **39**. It should also be recognized that since many of the components are addressable by the communication bus **39**, a user may manually input and address a particular component and selectively configure that component if desired.

An undesirable artifact of dual conversion is the generation of harmonics based on the fundamental oscillator frequencies. The harmonics of the second and third PLL frequency synthesizers **49, 51** mix with each other, thereby creating ODBFs. To obviate the intrusive effects of these PLL harmonics, the system and method of the present invention **19** eliminate this type of interference by translating the significant ODBFs out of the desired output channel.

A flowchart of the preferred method of the present invention **19** is shown in **Figure 5**. Upon making the necessary connections to the CATV cable **15** and subscriber's television receiver, the settop terminal **17** is energized **(step 201)** establishing communication with the system headend. If the cable system headend has forward communication ability **(step 205)**, the settop terminal is instructed how to configure itself for the applicable broadcast standard by downloading the parameters for the regional standards being used and the channel broadcast maps **(step 207)**. The predetermined PLL frequencies derived from the channel and broadcast maps in memory are converted into corresponding "divide-by" numbers for the PLL modulo-*n* converters **87**, **89** and output to the second **49** and third **51** PLL frequency synthesizers. The

settop terminal **17** acknowledges when configuration is complete. If the cable system does not have forward communication capability, the user will be prompted to enter the applicable information via a display and keypad, thereby manually loading the applicable broadcast configuration **(step 209)**.

The settop terminal **19** reviews the loaded channel and broadcast maps. The predetermined frequencies are examined for potential ODBFs **(step 211)**. If it is determined that ODBF's are likely **(step 213)**, an ODBF translation is performed **(step 215)** as shown in **Figure 6** (which will be explained in greater detail hereafter). Otherwise, the original frequencies are maintained **(step 217)** (**Figure 5**). The frequencies are addressed to their respective PLL synthesizers as words over the I^2C communication bus **(step 219)**.

Referring to the flow diagram of **Figure 6**, the elimination of ODBFs is achieved by selectively adjusting the frequencies of the second **49** and third PLLs **51** to obtain the desired RF output frequency. For a typical NTSC signal, the up-converter mixer **91** modulates the input video **59** and audio signals **67** with the output **93** of the second PLL **49** to up-convert the input RF signal of the selected channel to the HI-IF **93 (step 301)**.

$$LO1 = \text{audio carrier frequency} \qquad \textbf{(Equation 1)}$$

$$LO2 = \text{HI-IF} \qquad \textbf{(Equation 2)}$$

The down-converter mixer mixes **101** the HI-IF **93** with the output of the third PLL synthesizer **51** **(step 303)** to down-convert, (or further up-convert if desired), to obtain the desired RF output frequency **105**.

$$LO3 = (HI - IF) + RF\ output \qquad \textbf{(Equation 3)}$$

Multiples of the second and third PLL synthesizer **49, 51** fundamental frequencies define the even and odd harmonics,

$$m(LO2)\ and\ m(LO3),\ for\ m = 1, 2, 3, 4, \ldots \infty, \qquad \textbf{(Equation 4)}$$

which represent all possible harmonics **(step 305)**. However, due to the high system frequencies involved, examination of frequencies beyond the 10th harmonic is unnecessary.

The existence of an interfering ODBF is determined by serially calculating the differences between two harmonics of the second **49** and **51** third PLL synthesizers that are separated by at least one degree until the absolute value of an $ODBFm,n$ is within a given bandwidth or a predetermined number of $ODBFm,n$ values are calculated. When an $ODBFm,n$ absolute value is found within the RF channel bandwidth, it is designated as an interfering oscillator difference beat frequency (ODBF). The general equation for calculating ODBFs is:

$$OBDF_{m,n} = (m + n)\,(LO2) - (m)(LO3),\ for\ m = 1, 2, 3, 4, \ldots 10,$$

(Equation 5)

with $n = 1$ for a first series, $n = 2$ for a second series, $n = 3$ for a third series, and so on up to $n = 8$ for all previously calculated harmonics **(step 305)**. The $ODBFm,n$ calculated from the differing degrees of the second **49** and third PLL **51** harmonics are then examined **(step 307)**. For example, if the ODBF lies outside of the desired RF output channel bandwidth, no adjustment of the second **49** and third **51** PLL frequency synthesizers is required.

For an ODBF which falls inband, the following equations can be used to determine which direction the second **49** and third **51** PLL frequencies should be adjusted to translate the ODBF out of band. In these equations, CLB is the channel low-band; CMB is the channel mid-band; and CHB is the channel high-band.

If -CHB≤ODBF<-CMB; then HI-IF is moved downward. **(Equation 6A)**

(If the result of **Equation 5** is negative and the magnitude is greater than the mid-band of the desired RF output channel **(step 309)**, the HI-IF is moved downward **(step 311)**).

If -CMB≤ODBF≤-CLB; then HI-IF is moved upward. **(Equation 6B)**

(If the result of **Equation 5** is negative and the magnitude is less than or equal to the mid-band of the desired RF output channel **(step 313)**, the HI-IF is moved upward **(step 315)**).

If CLB≤ODBF≤CMB; then HI-IF is moved downward. **(Equation 6C)**

(If the result of **Equation 5** is positive and the magnitude is less or equal to than the mid-band of the desired RF output channel **(step 317)**, the HI-IF is moved downward **(step 319)**).

If CMB<ODBF≤CHB; then HI-IF is moved upward. **(Equation 6D)**

(If the result of **Equation 5** is positive and the magnitude is greater than the mid-band of the desired RF output channel **(step 321)**, the HI-IF is moved upward **(step 323)**).

The second **49** and third **51** PLLs are then adjusted **(step 327)** in accordance with the following: To translate the oscillator difference beats below or above the desired RF output channel, the following equation is used to determine the Δ in

frequency for the second **49** and third **51** PLL frequency synthesizers.

$$\Delta = \frac{CMB - [(m+n)(LO2) - m(LO3)]}{(m+n) - m} \quad \textbf{(Equation 7)}$$

The new second **49** and third **51** PLL frequencies (LO2' and LO3' respectively) are derived as shown in LO2' is calculated as shown in **Figure 6**.

The new PLL frequencies LO2' and LO3' translate the ODBFs above or below the desired RF output channel. The new PLL frequency values are used to program the second **49** and third **51** PLL frequency synthesizers **(step 327)**.

In an alternative embodiment, a fixed value for Δ can be used to simplify the calculations and the operation of the system. For example, a value of 4 MHz for Δ will suffice for NTSC and PAL systems.

The present invention will now be explained with reference to several examples. In the first example, if the HI-IF is 960 MHz and the desired RF output channel has a picture carrier frequency of 319.25 MHz, we have the following:

LO2 = HI-IF = 960 MHz; and **(from Equation 2)**

LO3 = HI-IF + RF output **(from Equation 3)**

= 960 + 319.25 = 1279.25 MHz.

The graph for ODBFs versus the RF output frequencies for m=2 and n=1 is shown in **Figure 9A**. If m=2 and n=1, then:

$$ODBF_{2,1}(960) = (m+n)(LO2) - m(LO3) \quad \textbf{(from Equation 5)}$$
$$= 3(960) - 2(1279.25)$$
$$= 2880 - 2558.5 = 321.5 \text{ MHz}$$

Since the desired RF output channel has a picture carrier frequency of 319.25 MHz (and assuming the bandwidth is 6 MHz for an NTSC channel), the ODBF is in-band for the desired RF output channel. From **Equation 6D**, since the ODBF is above the mid-band of the desired RF output channel, the HI-IF is moved upward. Assuming that Δ will be a fixed value of 4 MHz, LO2' will be 964 MHz and LO3' will be 1283.25 MHz. Accordingly, from **Equation 5**:

$$ODBF_{2,1}(964) = 3(964) - 2(964+319.25)$$
$$= 2892 - 2566.5 = 325.5 \text{ MHz}$$

The ODBF is now out of band.

In the second example, if the HI-IF is 960 MHz and the desired RF output channel has a picture carrier frequency of 481.25 MHz, we then have the following:

$$LO2 = \text{HI-IF} = 960 \text{ MHz; and} \quad \textbf{(from Equation 2)}$$

$$LO3 = \text{HI-IF} + \text{RF output} \quad \textbf{(from Equation 3)}$$
$$= 960 + 481.25 = 1441.25 \text{ MHz.}$$

The graph for ODBFs versus the RF output frequencies for m=3 and n=1 is shown in **Figure 9B**. If m=3 and n=1, the ODBF can be calculated as:

$$ODBF_{3,1}(960) = 4(960)-3(1441.25) \quad \textbf{(from Equation 5)}$$
$$= 3840-4323.75$$
$$= -483.75MHz.$$

Since the selected channel is 481.25 MHz, (and assuming an NTSC channel), the ODBF is in-band and the HI-IF must be relocated. The result of **Equation 5** for this example is negative and the magnitude is greater than the mid-band of the desired RF output channel (481.25 MHz). Accordingly, from **Equation 6A**, the HI-IF is moved lower. Assuming that Δ will be a fixed value of 4 MHz, LO2' will be 956 MHz and LO3' will be 1437.25 MHz. Recalculating the ODBF provides:

$$ODBF_{3,1}(956) = 4(956)-3(956+481.25) \quad \textbf{(from Equation 5)}$$
$$= 3824-4311.75 = -487.75 \text{ MHz}.$$

The ODBF is now out of band.

Due to the simple design of the present invention and since there are no shielding requirements to avoid ODBFs, the universal modulator may be incorporated onto a single integrated circuit. This was not possible with prior art signs.

Although the present invention has been described with reference to a settop terminal, it should be understood by

those of skill in the art that the invention is adaptable to other applications within the CATV environment, or even other communication applications which do not pertain to CATV systems.

For example, as shown in **Figure 7**, a prior art headend **700** generally includes two pieces of equipment; a baseband section **702** and an IF section **704**. These two sections **702**, **704** are typically designed to operate as "stand alone" units. Together, the two sections **702**, **704** output a single RF channel. The baseband section **702** generally comprises a video section **706** and an audio section **708**. These sections **706**, **708** receive audio and video baseband inputs and combine these inputs to an intermediate frequency for output to the IF section **704**. In the IF section **704**, the intermediate frequency is up-converted to the desired RF output channel. Since both sections **702**, **704** comprise units of equipment which are designed to work independently, this requires the duplication of many components between units **702**, **704**.

Referring to **Figure 8**, a headend **800** made in accordance with the present invention is shown. The headend **800** includes an audio pre-processing section **802**, a video pre-processing section **804**, the universal modulator **808** of the present invention (which is coupled to two filters **810**, **812**), a transmitter **814** (if desired), and a microprocessor **806**, which controls all of the components of the headend **800**. As was previously described hereinbefore, since the universal modulator **808** can convert a baseband input signal to any desired RF output signal while avoiding ODBFs, the universal

modulator **808** may be utilized to replace most of the components in the baseband section **702** and the IF section **704**. This significantly reduces the number of components required for a headend **800**. Accordingly, the cost and complexity are also thereby reduced.

It should be understood by those of skill in the art, with reference to **Figure 8**, that the universal modulator **808** of the present invention may also be used to accept a baseband digital VSB signal and remodulate the signal to a desired RF output signal for use with broadcast HDTV television receivers. The universal modulator **808** could also be used to transmit RF signals to devices which require high frequency RF signals, including wireless appliances such as a cordless telephone or a wireless LAN receiver. In such an application, the second mixer up-converts the HI-IF signal to a higher frequency RF signal, instead of down-converting the HI-IF as previously described. The desired RF output signal would be:

$$\text{RF output} = (\text{HI-IF}) + \text{LO3} \qquad \textbf{(Equation 10)}$$

The RF output signal may then be transmitted directly to the wireless appliance.

* * *

WE CLAIM:

1. A communication module which receives an input RF signal and converts said input RF signal to a desired RF output signal, the communication module comprising:

a first frequency agile local oscillator for generating a first frequency for mixing with said input RF signal to generate a high intermediate frequency (HI-IF) signal;

a second frequency agile local oscillator for generating a second frequency for mixing with said HI-IF signal to generate said desired RF output signal;

a controller including:

means for controlling said first and second frequency agile local oscillators to obtain said desired RF output signal;

means for comparing said first frequency with said second frequency to determine whether any interfering oscillator difference beat frequencies (ODBFs) exist within the bandwidth of said desired RF output signal; and

means for adjusting said first and second frequency agile local oscillators such that said first and second frequencies move said interfering ODBFs outside the bandwidth of said desired RF output signal.

2. The communication module of claim 1 wherein the communication module receives a plurality of input RF signals and said communication module further includes a signal

selector for selecting one of said plurality of input RF signals for mixing with said first frequency.

3. The communication module of claim 1 further comprising a transmitter, for wirelessly transmitting said RF output signal to a receiver.

4. The communication module of claim 3, whereby said transmitted signal is transmitted within the UHF or VHF frequency bands.

5. The communication module of claim 1, whereby the communication module is encompassed within a single integrated circuit.

6. The communication module of claim 1, whereby the communication module comprises an RF receiver circuit.

7. The communication module of claim 1, whereby the communication module comprises an RF transmitter circuit.

8. The communication module of claim 1 wherein said selected signal represents an analog signal transmission.

9. The communication module of claim 1 wherein said selected signal represents a digital signal transmission.

10. The communication module of claim 2 wherein said controller further comprises collateral memory storing a channel map of channels to predetermined channel carrier frequencies;

means for receiving a specific channel selection request and inputting said request to said microprocessor; and

said microprocessor determines said initial first local oscillator frequency.

11. A universal modulator for receiving a plurality of baseband input signals and outputting a desired RF output signal comprising:

a first PLL frequency synthesizer for generating a first frequency for mixing with a baseband audio signal to relocate said baseband audio signal within a desired bandwidth;

a second PLL frequency synthesizer for generating a second frequency for mixing with a summed signal within the desired bandwidth which includes said relocated baseband audio signal and a baseband video signal to produce a HI-IF signal;

a third PLL frequency synthesizer for generating a third frequency for mixing with said HI-IF signal to produce an RF output signal;

means for selecting said first, second and third PLL frequency synthesizers based upon said desired RF output signal including:

means for determining a first PLL frequency for said first synthesizer;

means for determining a second initial PLL frequency for said second synthesizer;

means for comparing said second initial PLL frequency with a third initial PLL frequency for said third synthesizer to determine whether any interfering oscillator difference beat frequencies exist within the bandwidth of said RF output signal; and

means for adjusting said second and third initial PLL frequencies to move any interfering ODBFs out of the bandwidth of said RF output signal.

12. A method for receiving an input RF signal and converts said input RF signal to a desired RF output signal, the method comprising:

generating a first frequency for mixing with said input RF signal to generate a high intermediate frequency (HI-IF) signal;

generating a second frequency for mixing with said HI-IF signal to generate said desired RF output signal;

controlling said first and second frequency agile local oscillators to obtain said desired RF output signal;

comparing said first frequency with said second frequency to determine whether any interfering oscillator difference beat frequencies (ODBFs) exist within the bandwidth of said desired RF output signal; and

adjusting said first and second frequency agile local oscillators such that said first and second frequencies move

said interfering ODBFs outside the bandwidth of said desired RF output signal.

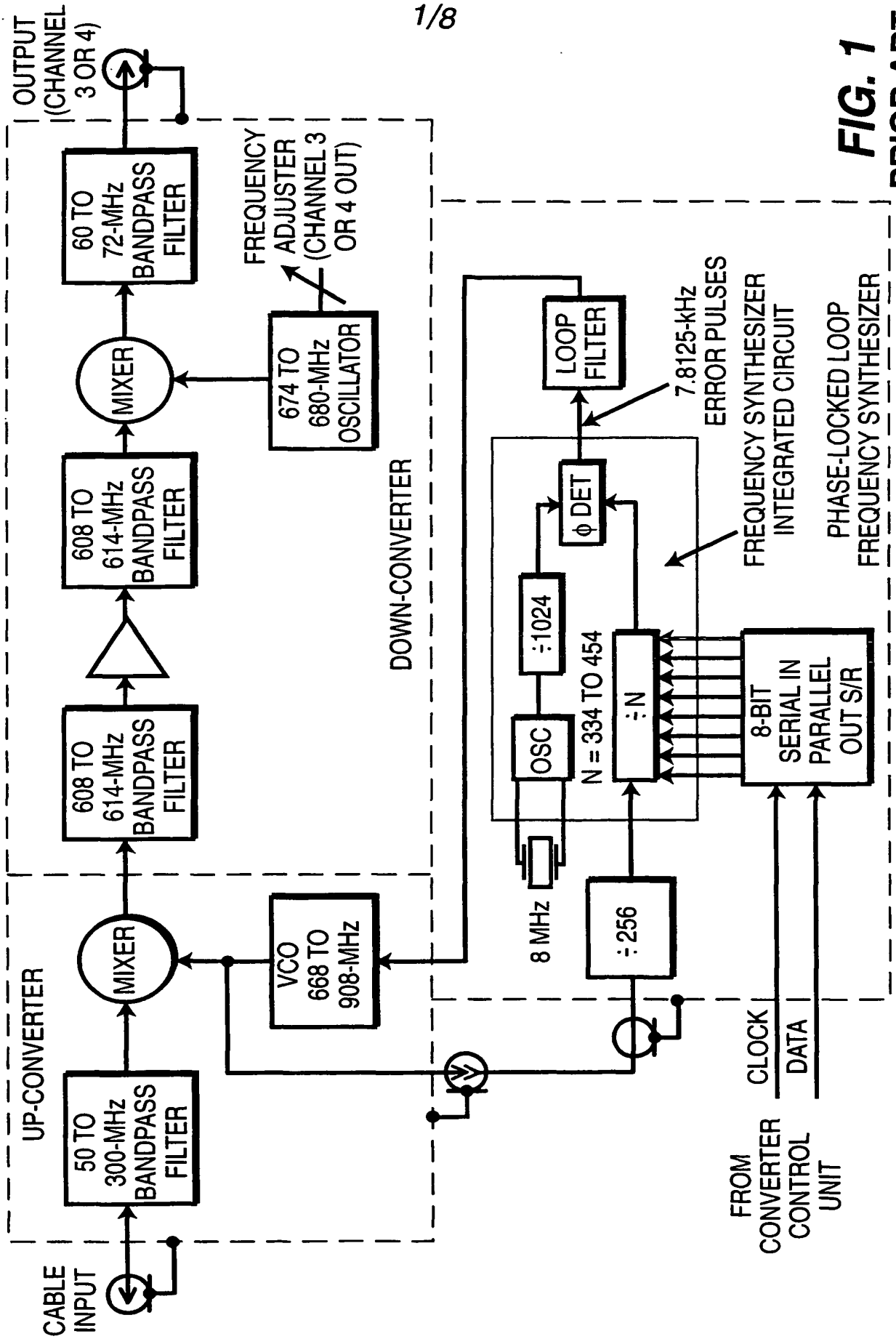


FIG. 1
PRIOR ART

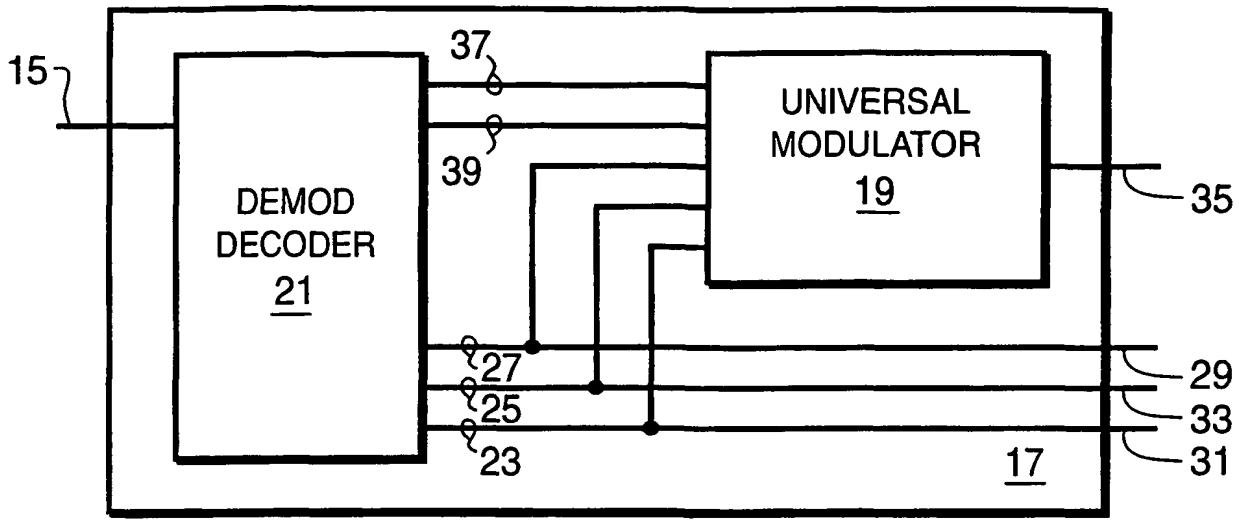

15
37
39
DEMOD
DECODER
21
UNIVERSAL
MODULATOR
19
35
27
25
23
29
33
31
17

FIG. 2

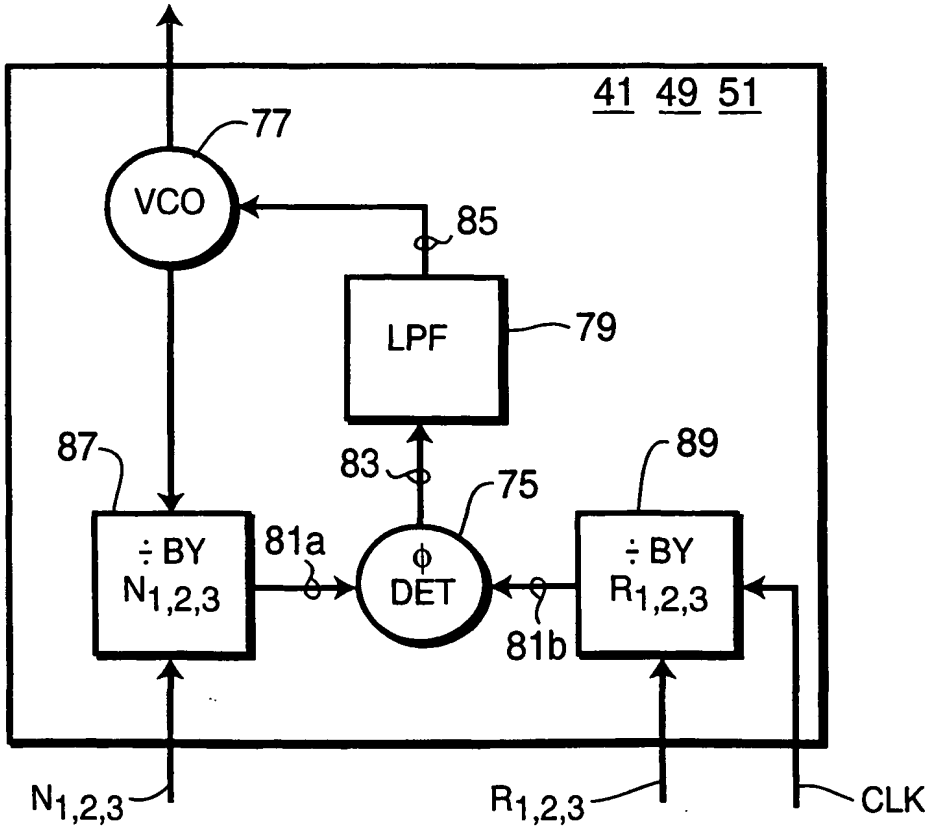

41 49 51
77
VCO
85
LPF
79
87
83
75
89
÷ BY
N1,2,3
81a
φ
DET
÷ BY
R1,2,3
81b
N1,2,3
R1,2,3
CLK

FIG. 4

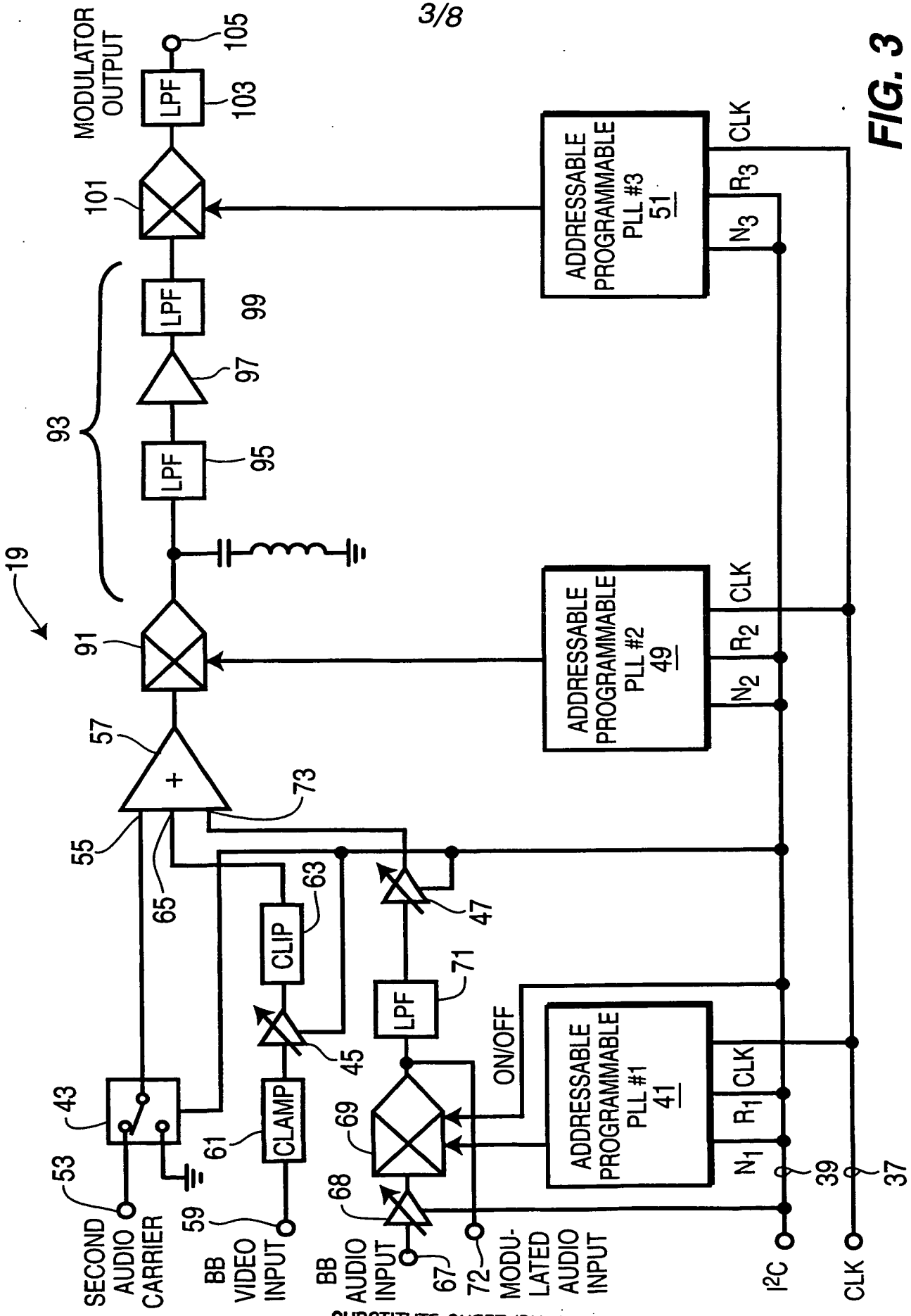

MODULATOR OUTPUT
105
LPF
103
101
LPF
99
97
93
LPF
95
19
91
57
+
73
55
65
63
CLIP
47
71
LPF
45
43
CLAMP
61
69
68
ON/OFF
ADDRESSABLE PROGRAMMABLE PLL #3 51
ADDRESSABLE PROGRAMMABLE PLL #2 49
ADDRESSABLE PROGRAMMABLE PLL #1 41
CLK
R_3
N_3
R_2
N_2
R_1
N_1
39
37
53
SECOND AUDIO CARRIER
59
BB VIDEO INPUT
BB AUDIO INPUT
67
72
MODU-LATED AUDIO INPUT
I^2C
CLK

FIG. 3

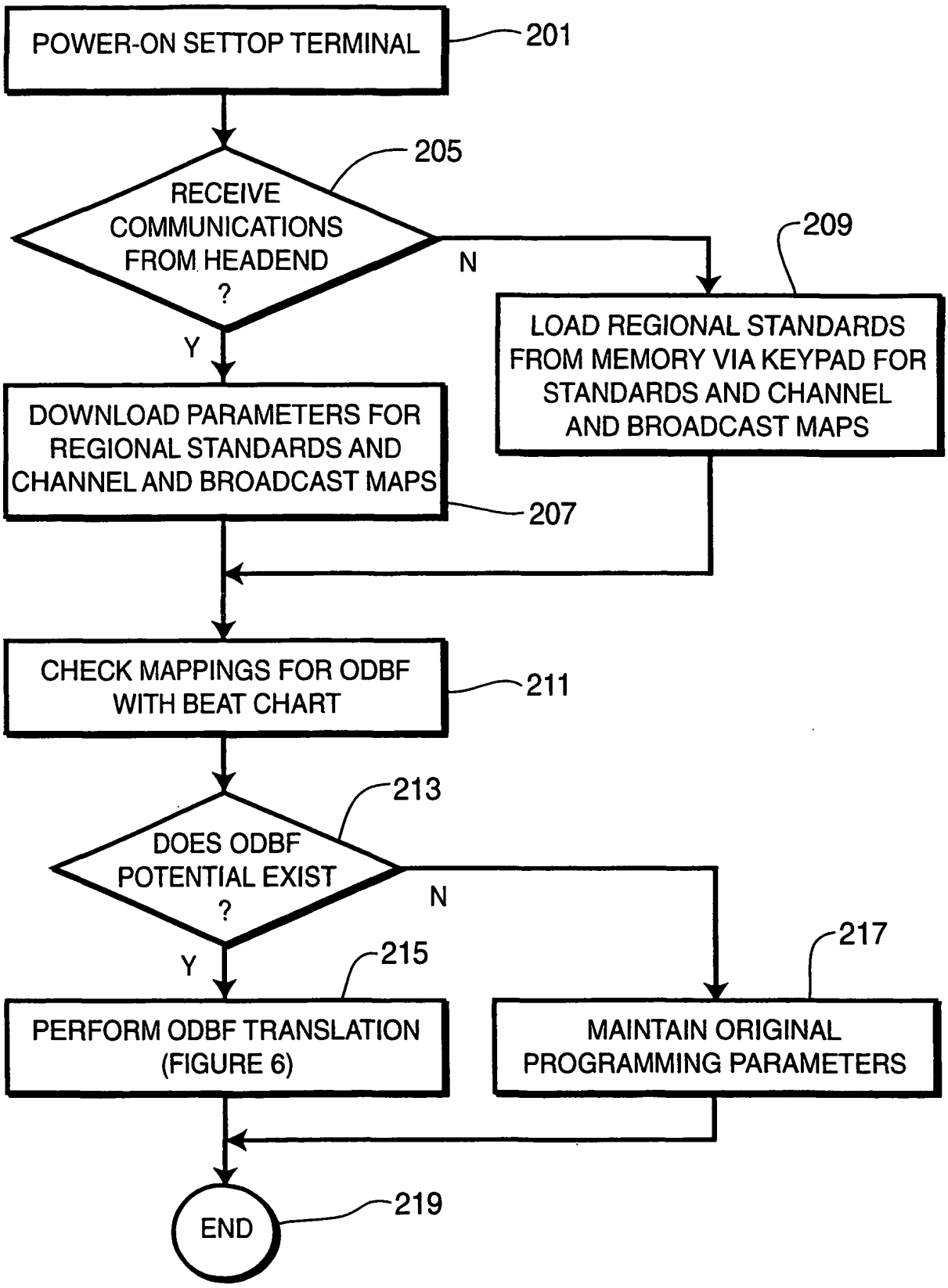

POWER-ON SETTOP TERMINAL
201
RECEIVE COMMUNICATIONS FROM HEADEND ?
205
N
209
LOAD REGIONAL STANDARDS FROM MEMORY VIA KEYPAD FOR STANDARDS AND CHANNEL AND BROADCAST MAPS
Y
DOWNLOAD PARAMETERS FOR REGIONAL STANDARDS AND CHANNEL AND BROADCAST MAPS
207
CHECK MAPPINGS FOR ODBF WITH BEAT CHART
211
DOES ODBF POTENTIAL EXIST ?
213
N
Y
215
217
PERFORM ODBF TRANSLATION (FIGURE 6)
MAINTAIN ORIGINAL PROGRAMMING PARAMETERS
END
219

FIG. 5

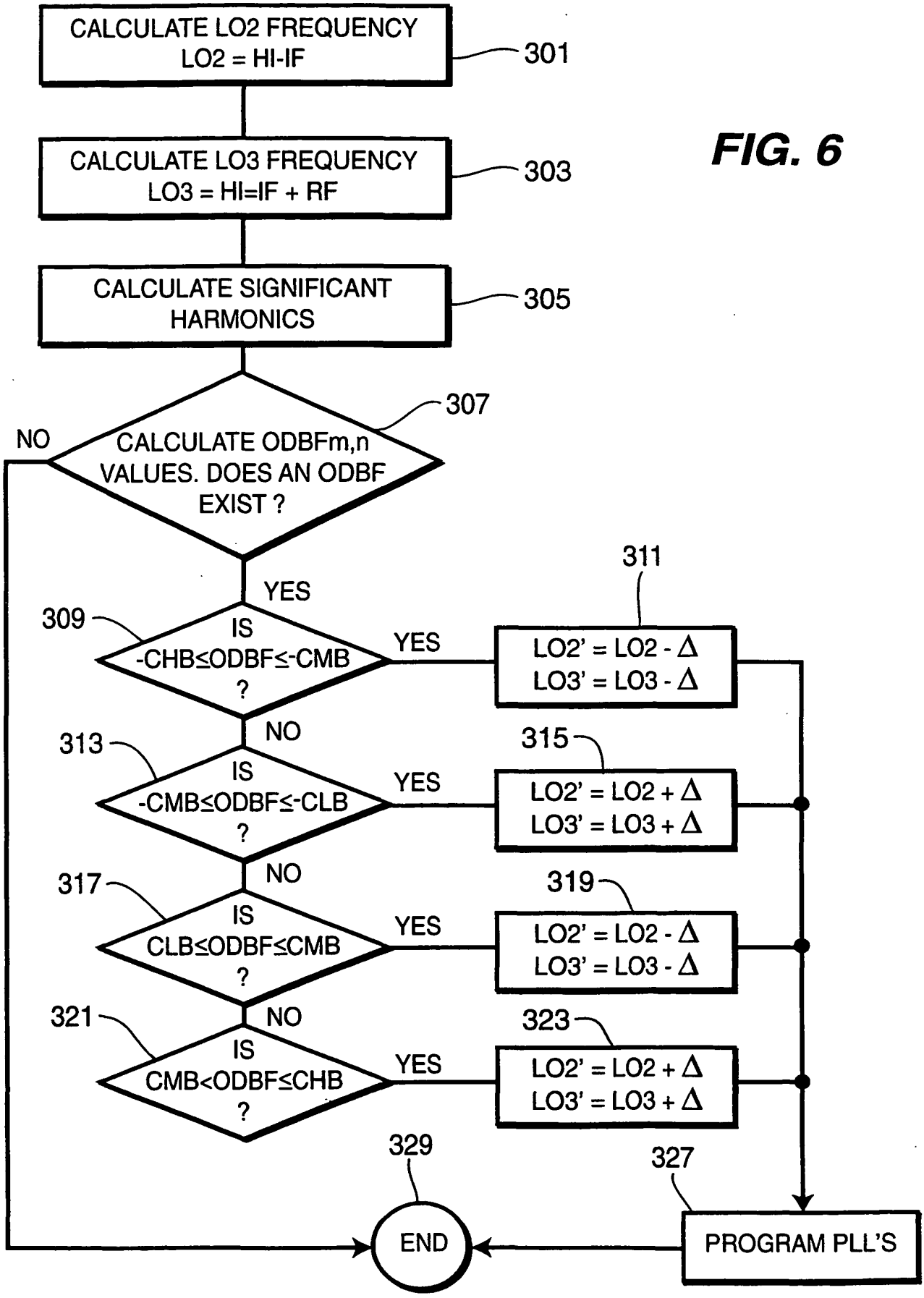

CALCULATE LO2 FREQUENCY
LO2 = HI-IF
301
CALCULATE LO3 FREQUENCY
LO3 = HI=IF + RF
303
CALCULATE SIGNIFICANT HARMONICS
305
307
CALCULATE ODBFm,n VALUES. DOES AN ODBF EXIST ?
NO
YES
309
IS -CHB≤ODBF≤-CMB ?
YES
311
LO2' = LO2 - Δ
LO3' = LO3 - Δ
NO
313
IS -CMB≤ODBF≤-CLB ?
YES
315
LO2' = LO2 + Δ
LO3' = LO3 + Δ
NO
317
IS CLB≤ODBF≤CMB ?
YES
319
LO2' = LO2 - Δ
LO3' = LO3 - Δ
NO
321
IS CMB<ODBF≤CHB ?
YES
323
LO2' = LO2 + Δ
LO3' = LO3 + Δ
329
END
327
PROGRAM PLL'S

FIG. 6

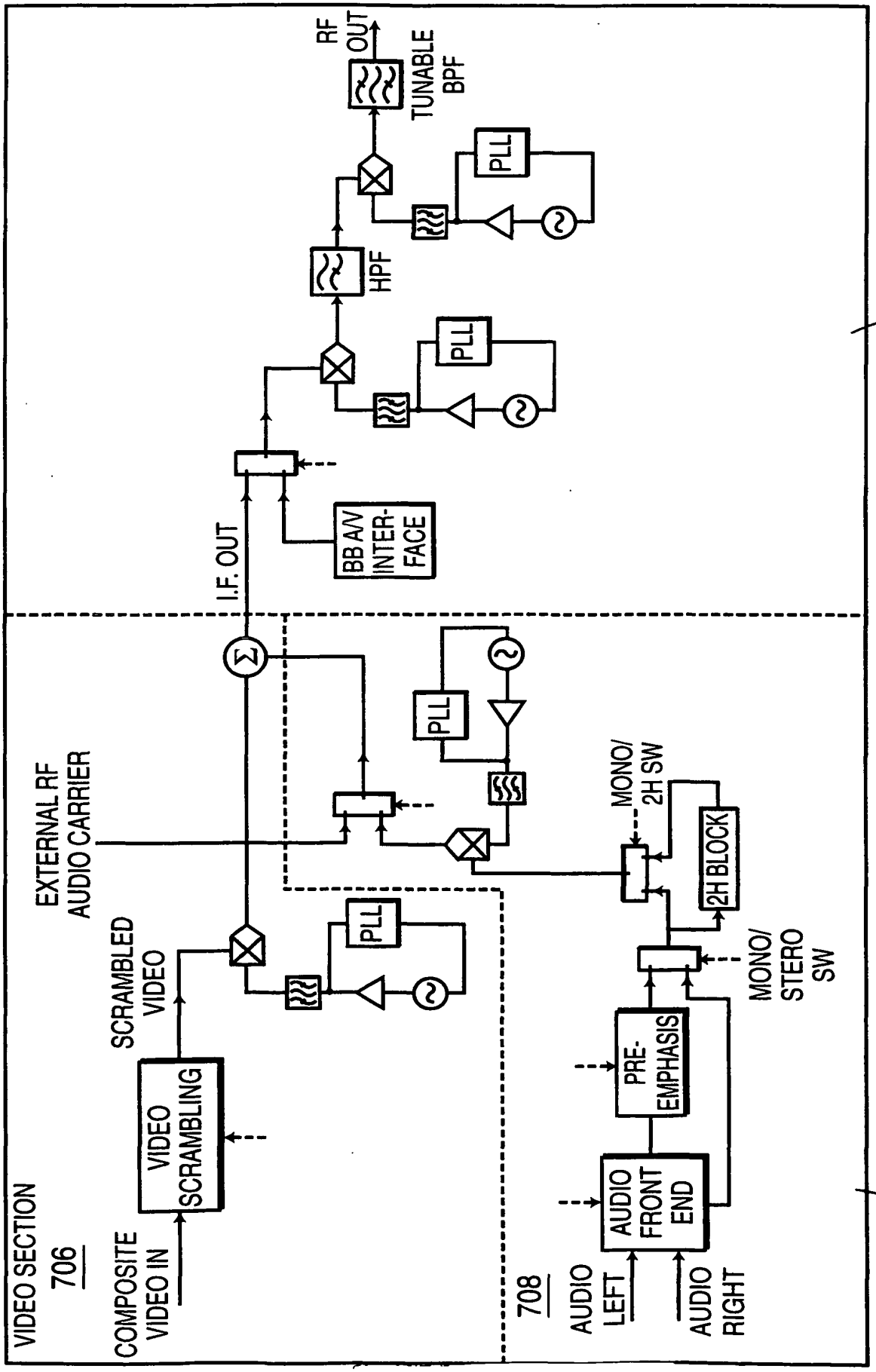


FIG. 7
PRIOR ART

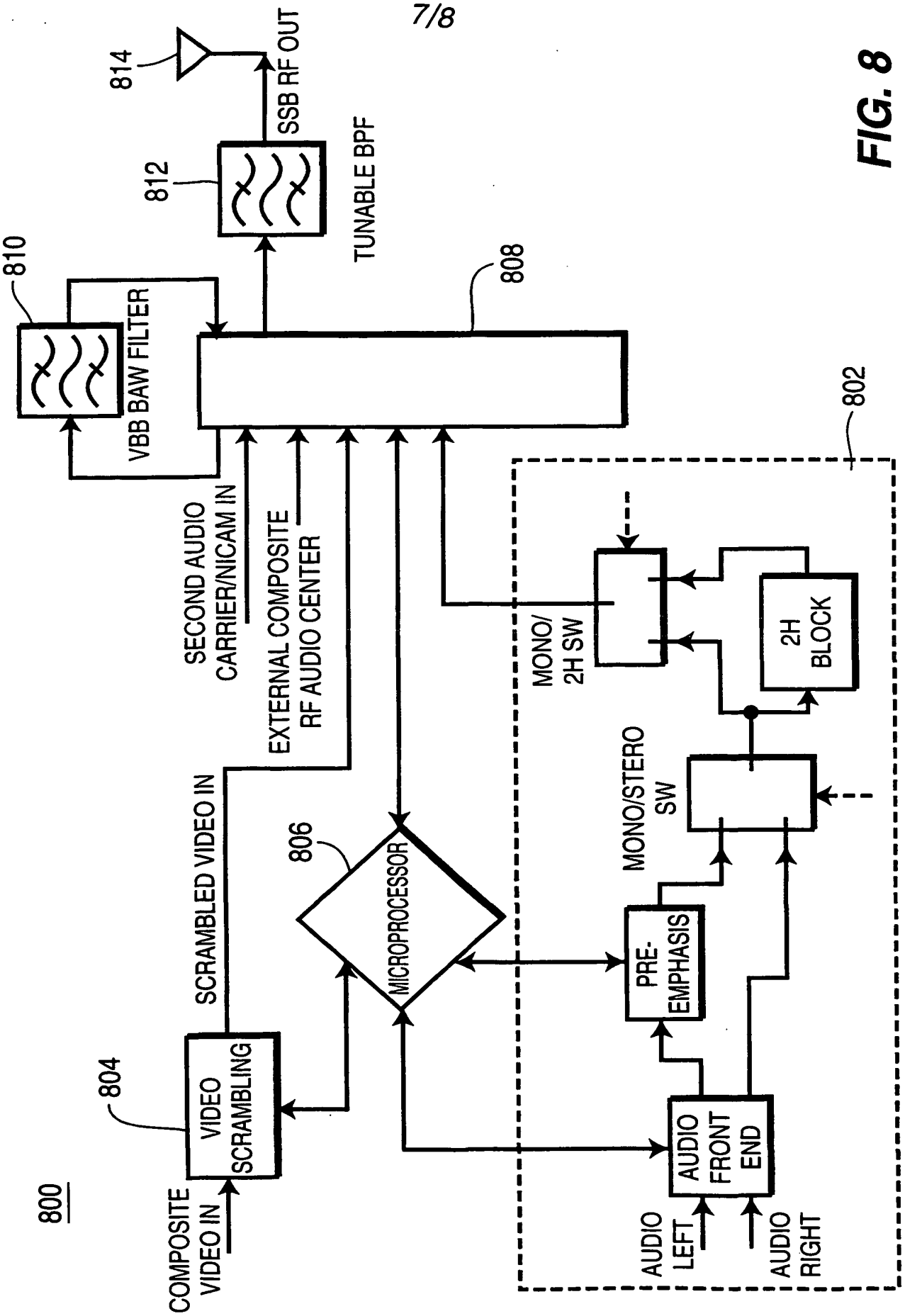

800
COMPOSITE VIDEO IN
804
VIDEO SCRAMBLING
SCRAMBLED VIDEO IN
806
MICROPROCESSOR
EXTERNAL COMPOSITE RF AUDIO CENTER
SECOND AUDIO CARRIER/NICAM IN
802
AUDIO LEFT
AUDIO RIGHT
AUDIO FRONT END
PRE-EMPHASIS
MONO/STERO SW
MONO/ 2H SW
2H BLOCK
808
810
VBB BAW FILTER
812
TUNABLE BPF
SSB RF OUT
814

FIG. 8

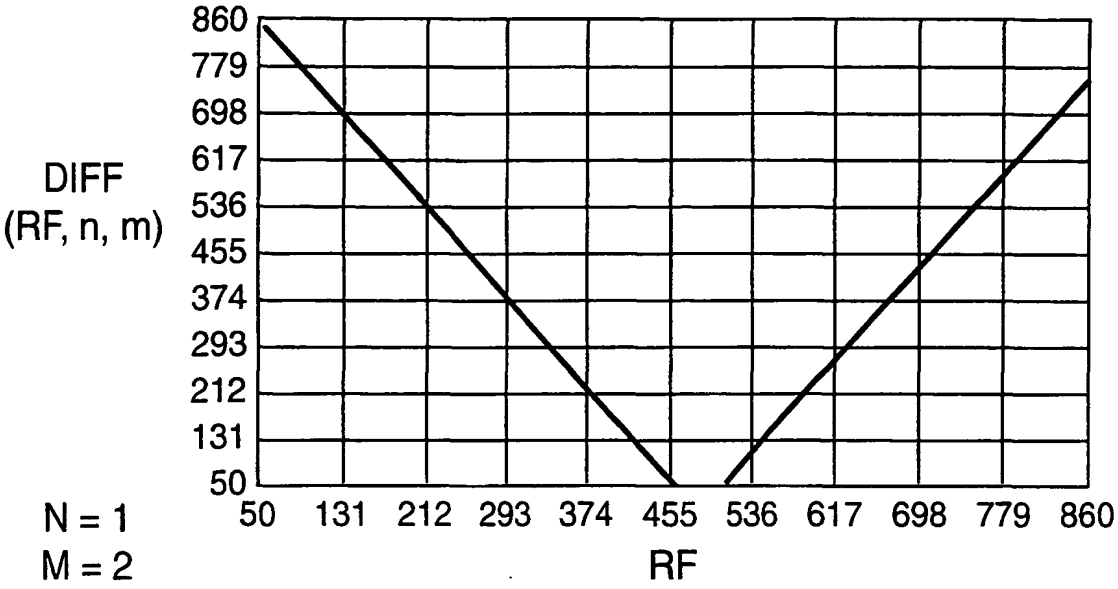

DIFF
(RF, n, m)
860
779
698
617
536
455
374
293
212
131
50
50 131 212 293 374 455 536 617 698 779 860
RF
N = 1
M = 2

FIG. 9A

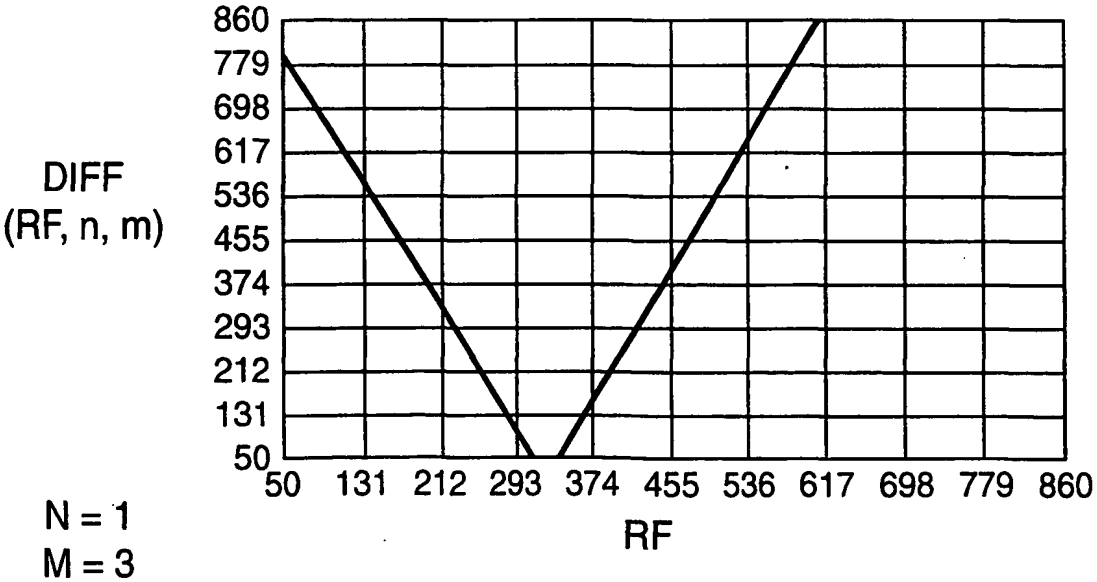

DIFF
(RF, n, m)
860
779
698
617
536
455
374
293
212
131
50
50 131 212 293 374 455 536 617 698 779 860
RF
N = 1
M = 3

FIG. 9B

PATENT COOPERATION TREATY

PCT

20 FEB 2001
PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

14

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
MOT-D2174WO		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US99/28232	30/11/1999	30/11/1998
International Patent Classification (IPC) or national classification and IPC H03D7/16		
Applicant GENERAL INSTRUMENT CORPORATION et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 6 sheets, including this cover sheet.

 ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

 These annexes consist of a total of 6 sheets.

3. This report contains indications relating to the following items:

 - I ☒ Basis of the report
 - II ☐ Priority
 - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
 - IV ☐ Lack of unity of invention
 - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
 - VI ☐ Certain documents cited
 - VII ☐ Certain defects in the international application
 - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
26/06/2000	26.02.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Fritzsche, H-V Telephone No. +49 89 2399 2394

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/28232

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H03D7/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H03D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 640 697 A (ORNDORFF DENNIS LEE) 17 June 1997 (1997-06-17) column 5, line 63 -column 6, line 59	1,11,12
X	DE 43 06 578 A (LOEWE OPTA GMBH) 8 September 1994 (1994-09-08) the whole document	1,12
A	WO 97 23034 A (WHITAKER CORP ;PRESCHUTTI JOSEPH P (US); FLICKINGER STEVEN LEE (US) 26 June 1997 (1997-06-26) page 4, line 28 -page 5, line 29	1,11,12
A	US 5 038 404 A (MARZ DANIEL) 6 August 1991 (1991-08-06) column 1, line 57 -column 5, line 68	1,11,12

-/—

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 March 2000	23/03/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Peeters, M

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Int[redacted]al Application No
PC[redacted]S 99/28232

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 84 04637 A (MOTOROLA INC) 22 November 1984 (1984-11-22)	

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

information on patent family members

International Application No
PCT/US 99/28232

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5640697 A	17-06-1997	US 5493210 A	20-02-1996
		US 5633582 A	27-05-1997
DE 4306578 A	08-09-1994	NONE	
WO 9723034 A	26-06-1997	AU 1421297 A	14-07-1997
		EP 0868775 A	07-10-1998
US 5038404 A	06-08-1991	NONE	
WO 8404637 A	22-11-1984	US 4512035 A	16-04-1985
		US 4551856 A	05-11-1985
		AT 48054 T	15-12-1989
		AU 562869 B	18-06-1987
		AU 3012784 A	04-12-1984
		CA 1221741 A	12-05-1987
		CA 1224530 C	21-07-1987
		DK 18385 A,B,	15-03-1985
		EP 0144394 A	19-06-1985
		FI 850167 A,B,	15-01-1985
		HK 17192 A	13-03-1992
		JP 60501338 T	15-08-1985
		NO 850159 A	15-01-1985
		SG 4592 G	20-03-1992

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/US99/28232

I. Basis of the report

1. This report has been drawn on the basis of *(substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments (Rules 70.16 and 70.17).)*:
Description, pages:

1,3-20	as originally filed			
2,2A	as received on	30/11/2000	with letter of	28/11/2000

Claims, No.:

1-12	as received on	30/11/2000	with letter of	28/11/2000

Drawings, sheets:

1/8-8/8	as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

 These elements were available or furnished to this Authority in the following language: , which is:

 - ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
 - ☐ the language of publication of the international application (under Rule 48.3(b)).
 - ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

 - ☐ contained in the international application in written form.
 - ☐ filed together with the international application in computer readable form.
 - ☐ furnished subsequently to this Authority in written form.
 - ☐ furnished subsequently to this Authority in computer readable form.
 - ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
 - ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

 (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-11
	No:	Claims	12
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-12
Industrial applicability (IA)	Yes:	Claims	1-12
	No:	Claims	

2. Citations and explanations
 see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1: US-A-5 640 697 (ORNDORFF DENNIS LEE) 17 June 1997 (1997-06-17)

D2: DE 43 06 578 A (LOEWE OPTA GMBH) 8 September 1994 (1994-09-08)

D3: WO 97 23034 A (WHITAKER CORP ;PRESCHUTTI JOSEPH P (US); FLICKINGER STEVEN LEE (US) 26 June 1997 (1997-06-26)

D4: US-A-5 038 404 (MARZ DANIEL) 6 August 1991 (1991-08-06)

D5: WO 84 04637 A (MOTOROLA INC) 22 November 1984 (1984-11-22)

1. In the description, page 16-18 an alternative embodiment is described. In this embodiment a fixed value for Δ is used. In this example the frequencies are shifted only by the fixed value of 4 MHz. This shifting is performed in positive and negative direction. This is the same method as defined in **D2**.
Consequently, the document D2 is regarded as being the closest prior art to the subject-matter of **claim 12**, and insofar as this claim can be understood (see Section VIII), this document shows the following features thereof (the references in parentheses applying to this document):
A method for receiving an input RF signal and converting said input RF signal to a desired RF output signal, the method comprising:
generating a first frequency (5, LO1) for mixing with said input RF signal to generate a high intermediate frequency signal;
generating a second frequency (12,LO2) for mixing with said HI-IF signal to generate said desired RF output signal;
controlling (16) said first and second frequency agile local oscillators to obtain said desired RF output signal;
comparing said first frequency with said second frequency (page 3, lines 12-25) to determine whether any interfering oscillator difference beat frequencies exist within the bandwidth of said desired RF output signal;
and for "calculating" a delta value (The first delta value is -Δ, the second delta value is +Δ; page 3 lines 66-68) to avoid said OBDFs and
adjusting said first and second frequency agile local oscillators by said delta values such that said first and second frequencies move said interfering ODBFs

outside the bandwidth of said desired RF output signal (page 3, line 66-page 4, line 12). Consequently, the subject-matter of independent claim 12 is not new and does not therefore meet the requirements of Article 33(2) of the PCT.

2. If the "calculation" were interpreted as creating different absolute values, then this could not support an inventive step. The problem to be solved were supporting finer adjustment. It is generally known hat this could be reached with creating (calculating) a lot of values for the adjustment with fine steps.

3. **Claim 1** claims a communication module employing the method of claim 12. The device of D2 could be defined to be a communication module. In D2 the comparing is however performed in the lists (page 3, lines 12-25) instead of a comparator. A direct comparison of frequencies is shown in D3, Fig.6. Thus, the subject-matter of claim 1 does not involve an inventive step and does not satisfy the criterion set forth in Article 33(3) PCT.

4. **Claim 11** claims a modification of the basic idea of claims 1 and 12. Most of the features of claim 11 are known from D2 (or D1). Contrary to claim 1 and 12 a "calculation" is not performed. The difference of claim 11 over D2 (or D1) is that the third PLL synthesizer is controlled. This is however a slight modification of the basic idea of the system of D1. Thus, the subject-matter of **claim 11** does not involve an inventive step and does not satisfy the criterion set forth in Article 33(3) PCT.

5. The features of claims 2, 6 and 8 are known form D2. The other dependent claims contain only minor features known from document D1-D5 or well known to the man skilled in the art. The subject-matter of these claims is accordingly lacking inventive step contrary to Article 33(3), PCT.

Re Item VIII

Certain observations on the international application

It is only possible to put reference signs in parentheses. In the claims "ODBF" should be replaced by "oscillator difference beat frequency".

The wording "**calculation** " in claim 12 and 1 is **not clear**. A normal interpretation would expect different values with different absolute values.

However, on page 16-18 an alternative embodiment is described. In this embodiment a fixed value for Δ is used. In this example the frequencies are shifted only by the fixed value of 4 MHz in positive and negative direction.

REPLACED BY
ART 34 AMDT

Most settop terminals are tunable. A block diagram for a prior art settop terminal is shown in **Figure 1**. Incoming signals from a CATV transmission network are coupled to an input bandpass amplifier and up-converted to a high intermediate frequency (HI-IF). The up-conversion requires a tunable local oscillator which selects a desired channel and an associated mixer. The mixer is coupled to a bandpass filter and down-converted to an IF channel using a fixed-frequency local oscillator and mixer. The output channel is filtered and forwarded to a subscriber's television receiver. Prior art settop terminals use one down-converter mixer with an oscillator having slight frequency agility to provide an output at one or two preselected channel frequencies. The output frequencies and bandwidths depend upon the transmission standard used.

In the United States, the NTSC (National Television System Committee) is the standard for color television. Other countries have chosen different systems. SECAM (*sequentiel couleur avec mémoire*) is used by France and Russia. PAL A and PAL B (phase alternation line) are used by many European countries such as Germany and the United Kingdom. Accordingly, television receivers are typically manufactured for a specific transmission standard. For worldwide use, a settop terminal must be adapted to the established broadcast standards.

Accordingly, there exists a need for an inexpensive method to adapt the output of a settop terminal to a variety of television broadcast standards.

WE CLAIM:

1. A communication module which receives an input RF signal and converts said input RF signal to a desired RF output signal, the communication module comprising:

a first frequency agile local oscillator for generating a first frequency for mixing with said input RF signal to generate a high intermediate frequency (HI-IF) signal;

a second frequency agile local oscillator for generating a second frequency for mixing with said HI-IF signal to generate said desired RF output signal;

a controller including:

means for controlling said first and second frequency agile local oscillators to obtain said desired RF output signal;

means for comparing said first frequency with said second frequency to determine whether any interfering oscillator difference beat frequencies (ODBFs) exist within the bandwidth of said desired RF output signal; and

means for adjusting said first and second frequency agile local oscillators such that said first and second frequencies move said interfering ODBFs outside the bandwidth of said desired RF output signal.

2. The communication module of claim 1 wherein the communication module receives a plurality of input RF signals and said communication module further includes a signal

selector for selecting one of said plurality of input RF signals for mixing with said first frequency.

3. The communication module of claim 1 further comprising a transmitter, for wirelessly transmitting said RF output signal to a receiver.

4. The communication module of claim 3, whereby said transmitted signal is transmitted within the UHF or VHF frequency bands.

5. The communication module of claim 1, whereby the communication module is encompassed within a single integrated circuit.

6. The communication module of claim 1, whereby the communication module comprises an RF receiver circuit.

7. The communication module of claim 1, whereby the communication module comprises an RF transmitter circuit.

8. The communication module of claim 1 wherein said selected signal represents an analog signal transmission.

9. The communication module of claim 1 wherein said selected signal represents a digital signal transmission.

10. The communication module of claim 2 wherein said controller further comprises collateral memory storing a channel map of channels to predetermined channel carrier frequencies;

means for receiving a specific channel selection request and inputting said request to said microprocessor; and

said microprocessor determines said initial first local oscillator frequency.

11. A universal modulator for receiving a plurality of baseband input signals and outputting a desired RF output signal comprising:

a first PLL frequency synthesizer for generating a first frequency for mixing with a baseband audio signal to relocate said baseband audio signal within a desired bandwidth;

a second PLL frequency synthesizer for generating a second frequency for mixing with a summed signal within the desired bandwidth which includes said relocated baseband audio signal and a baseband video signal to produce a HI-IF signal;

a third PLL frequency synthesizer for generating a third frequency for mixing with said HI-IF signal to produce an RF output signal;

means for selecting said first, second and third PLL frequency synthesizers based upon said desired RF output signal including:

means for determining a first PLL frequency for said first synthesizer;

means for determining a second initial PLL frequency for said second synthesizer;

means for comparing said second initial PLL frequency with a third initial PLL frequency for said third synthesizer to determine whether any interfering oscillator difference beat frequencies exist within the bandwidth of said RF output signal; and

means for adjusting said second and third initial PLL frequencies to move any interfering ODBFs out of the bandwidth of said RF output signal.

12. A method for receiving an input RF signal and converts said input RF signal to a desired RF output signal, the method comprising:

generating a first frequency for mixing with said input RF signal to generate a high intermediate frequency (HI-IF) signal;

generating a second frequency for mixing with said HI-IF signal to generate said desired RF output signal;

controlling said first and second frequency agile local oscillators to obtain said desired RF output signal;

comparing said first frequency with said second frequency to determine whether any interfering oscillator difference beat frequencies (ODBFs) exist within the bandwidth of said desired RF output signal; and

adjusting said first and second frequency agile local oscillators such that said first and second frequencies move

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
MOT-D2174WO		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US99/28232	30/11/1999	30/11/1998
International Patent Classification (IPC) or national classification and IPC H03D7/16		
Applicant GENERAL INSTRUMENT CORPORATION et al		

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 - VI ☐ Certain documents cited
 - VII ☐ Certain defects in the international application
 - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
26/06/2000	26.02.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Fritzsche, H-V Telephone No. +49 89 2399 2394

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/US99/28232

I. Basis of the report

1. This report has been drawn on the basis of *(substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments (Rules 70.16 and 70.17).)*:
Description, pages:

1,3-20	as originally filed			
2,2A	as received on	30/11/2000	with letter of	28/11/2000

Claims, No.:

1-12	as received on	30/11/2000	with letter of	28/11/2000

Drawings, sheets:

1/8-8/8	as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

 These elements were available or furnished to this Authority in the following language: , which is:

 - ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
 - ☐ the language of publication of the international application (under Rule 48.3(b)).
 - ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

 - ☐ contained in the international application in written form.
 - ☐ filed together with the international application in computer readable form.
 - ☐ furnished subsequently to this Authority in written form.
 - ☐ furnished subsequently to this Authority in computer readable form.
 - ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
 - ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

 (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-11
	No:	Claims	12
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-12
Industrial applicability (IA)	Yes:	Claims	1-12
	No:	Claims	

2. Citations and explanations
 see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1: US-A-5 640 697 (ORNDORFF DENNIS LEE) 17 June 1997 (1997-06-17)

D2: DE 43 06 578 A (LOEWE OPTA GMBH) 8 September 1994 (1994-09-08)

D3: WO 97 23034 A (WHITAKER CORP ;PRESCHUTTI JOSEPH P (US); FLICKINGER STEVEN LEE (US) 26 June 1997 (1997-06-26)

D4: US-A-5 038 404 (MARZ DANIEL) 6 August 1991 (1991-08-06)

D5: WO 84 04637 A (MOTOROLA INC) 22 November 1984 (1984-11-22)

1. In the description, page 16-18 an alternative embodiment is described. In this embodiment a fixed value for Δ is used. In this example the frequencies are shifted only by the fixed value of 4 MHz. This shifting is performed in positive and negative direction. This is the same method as defined in **D2**.
Consequently, the document D2 is regarded as being the closest prior art to the subject-matter of **claim 12**, and insofar as this claim can be understood (see Section VIII), this document shows the following features thereof (the references in parentheses applying to this document):
A method for receiving an input RF signal and converting said input RF signal to a desired RF output signal, the method comprising:
generating a first frequency (5, LO1) for mixing with said input RF signal to generate a high intermediate frequency signal;
generating a second frequency (12,LO2) for mixing with said HI-IF signal to generate said desired RF output signal;
controlling (16) said first and second frequency agile local oscillators to obtain said desired RF output signal;
comparing said first frequency with said second frequency (page 3, lines 12-25) to determine whether any interfering oscillator difference beat frequencies exist within the bandwidth of said desired RF output signal;
and for "calculating" a delta value (The first delta value is -Δ, the second delta value is +Δ; page 3 lines 66-68) to avoid said OBDFs and
adjusting said first and second frequency agile local oscillators by said delta values such that said first and second frequencies move said interfering ODBFs

outside the bandwidth of said desired RF output signal (page 3, line 66-page 4, line 12). Consequently, the subject-matter of independent claim 12 is not new and does not therefore meet the requirements of Article 33(2) of the PCT.

2. If the "calculation" were interpreted as creating different absolute values, then this could not support an inventive step. The problem to be solved were supporting finer adjustment. It is generally known hat this could be reached with creating (calculating) a lot of values for the adjustment with fine steps.

3. **Claim 1** claims a communication module employing the method of claim 12. The device of D2 could be defined to be a communication module. In D2 the comparing is however performed in the lists (page 3, lines 12-25) instead of a comparator. A direct comparison of frequencies is shown in D3, Fig.6. Thus, the subject-matter of claim 1 does not involve an inventive step and does not satisfy the criterion set forth in Article 33(3) PCT.

4. **Claim 11** claims a modification of the basic idea of claims 1 and 12. Most of the features of claim 11 are known from D2 (or D1). Contrary to claim 1 and 12 a "calculation" is not performed. The difference of claim 11 over D2 (or D1) is that the third PLL synthesizer is controlled. This is however a slight modification of the basic idea of the system of D1. Thus, the subject-matter of **claim 11** does not involve an inventive step and does not satisfy the criterion set forth in Article 33(3) PCT.

5. The features of claims 2, 6 and 8 are known form D2. The other dependent claims contain only minor features known from document D1-D5 or well known to the man skilled in the art. The subject-matter of these claims is accordingly lacking inventive step contrary to Article 33(3), PCT.

Re Item VIII

Certain observations on the international application

It is only possible to put reference signs in parentheses. In the claims "ODBF" should be replaced by "oscillator difference beat frequency".

The wording "**calculation** " in claim 12 and 1 is **not clear**. A normal interpretation would expect different values with different absolute values.

However, on page 16-18 an alternative embodiment is described. In this embodiment a fixed value for Δ is used. In this example the frequencies are shifted only by the fixed value of 4 MHz in positive and negative direction.

Most settop terminals are tunable. A block diagram for a prior art settop terminal is shown in **Figure 1**. Incoming signals from a CATV transmission network are coupled to an input bandpass amplifier and up-converted to a high intermediate frequency (HI-IF). The up-conversion requires a tunable local oscillator which selects a desired channel and an associated mixer. The mixer is coupled to a bandpass filter and down-converted to an IF channel using a fixed-frequency local oscillator and mixer. The output channel is filtered and forwarded to a subscriber's television receiver. Prior art settop terminals use one down-converter mixer with an oscillator having slight frequency agility to provide an output at one or two preselected channel frequencies. The output frequencies and bandwidths depend upon the transmission standard used.

In the United States, the NTSC (National Television System Committee) is the standard for color television. Other countries have chosen different systems. SECAM (*sequentiel couleur avec mémoire*) is used by France and Russia. PAL A and PAL B (phase alternation line) are used by many European countries such as Germany and the United Kingdom. Accordingly, television receivers are typically manufactured for a specific transmission standard. For worldwide use, a settop terminal must be adapted to the established broadcast standards.

U.S. Patent No. 5,640,697 teaches the use of two predetermined frequencies for each local oscillator, whereby the second oscillator frequency can be adjusted independently of the first oscillator frequency. Adjustment between the two

frequencies is used to adapt to the different output frequencies, while eliminating noise caused by the local oscillators. Similar to U.S. Patent No. 5,640,497, German Patent No. Application 4,306,578 adjusts the oscillator frequencies by a predetermined amount in order to eliminate noise. PCT International Patent Application No. 84/04637 employs two local oscillators that generate predetermined frequencies, in which the second oscillator is selected between one of two frequencies to eliminate this noise.

Accordingly, there exists a need for an inexpensive method to adapt the output of a settop terminal to a variety of television broadcast standards.

WE CLAIM:

1. A communication module which receives an input RF signal and converts said input RF signal to a desired RF output signal (105), the communication module comprising:

a first frequency agile local oscillator (49) for generating a first frequency for mixing with said input RF signal to generate a high intermediate frequency (HI-IF) signal;

a second frequency agile local oscillator (51) for generating a second frequency for mixing with said HI-IF signal to generate said desired RF output signal (105);

a processor including:

a controller for controlling said first and second frequency agile local oscillators (49, 51) to obtain said desired RF output signal (105); and

a comparator for comparing said first frequency with said second frequency to determine whether any interfering oscillator difference beat frequencies (ODBFs) exist within the bandwidth of said desired RF output signal (105), and for calculating a delta value to avoid said ODBFs; whereby said processor adjusts said first and second frequency agile local oscillators by said delta value such that said first and second frequencies move said interfering ODBFs outside the bandwidth of said desired RF output signal (105).

2. The communication module of claim 1 wherein the communication module receives a plurality of input RF signals and said communication module further includes a signal selector for

selecting one of said plurality of input RF signals for mixing with said first frequency.

3. The communication module of claim 1 further comprising a transmitter, for wirelessly transmitting said RF output signal (105) to a receiver.

4. The communication module of claim 3, whereby said transmitted signal is transmitted within the UHF or VHF frequency bands.

5. The communication module of claim 1, whereby the communication module is encompassed within a single integrated circuit.

6. The communication module of claim 1, whereby the communication module comprises an RF receiver circuit.

7. The communication module of claim 1, whereby the communication module comprises an RF transmitter circuit.

8. The communication module of claim 1 wherein said selected signal represents an analog signal transmission.

9. The communication module of claim 1 wherein said selected signal represents a digital signal transmission.

10. The communication module of claim 2 wherein said processor further comprises collateral memory for storing a channel map of channels to predetermined channel carrier frequencies; whereby said processor receives a specific channel selection request and determines said initial first local oscillator frequency.

11. A universal modulator for receiving a plurality of baseband input signals and outputting a desired RF output signal (105) comprising:

a first PLL frequency synthesizer (41) for generating a first frequency for mixing with a baseband audio signal to relocate said baseband audio signal within a desired bandwidth;

a second PLL frequency synthesizer (49) for generating a second frequency for mixing with a summed signal within the desired bandwidth which includes said relocated baseband audio signal and a baseband video signal to produce a HI-IF signal;

a third PLL frequency synthesizer (51) for generating a third frequency for mixing with said HI-IF signal to produce an RF output signal (105); and

a processor for selecting said first (41), second (49) and third (51) PLL frequency synthesizers based upon said desired RF output signal (105) whereby said processor:

determines a first PLL frequency for said first synthesizer (41);

determines a second initial PLL frequency for said second synthesizer (49);

compares said second initial PLL frequency with a third initial PLL frequency for said third synthesizer (51) to determine whether any interfering oscillator difference beat frequencies exist within the bandwidth of said RF output signal (105); and

adjusts said second and third initial PLL frequencies to move any interfering ODBFs out of the bandwidth of said RF output signal (105).

12. A method for receiving an input RF signal and converting said input RF signal to a desired RF output signal (105), the method comprising:

generating a first frequency for mixing with said input RF signal to generate a high intermediate frequency (HI-IF) signal;

generating a second frequency for mixing with said HI-IF signal to generate said desired RF output signal (105);

controlling said first and second frequency agile local oscillators to obtain said desired RF output signal (105);

comparing said first frequency with said second frequency to determine whether any interfering oscillator difference beat frequencies (ODBFs) exist within the bandwidth of said desired RF output signal (105), and for calculating a delta value to avoid said ODBFs; and

adjusting said first and second frequency agile local oscillators by said delta value such that said first and second frequencies move said interfering ODBFs outside the bandwidth of said desired RF output signal.

ATENT COOPERATION TR[illegible]TY

From the:
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

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VOLPE & KOENIG, P.C.

PCT

WRITTEN OPINION

(PCT Rule 66)

Date of mailing *(day/month/year)*	28.08.2000
Applicant's or agent's file reference: MOT-D2174WO	**REPLY DUE** **within 3 month(s)** from the above date of mailing

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US99/28232	30/11/1999	30/11/1998

International Patent Classification (IPC) or both national classification and IPC

H03D7/16

Applicant

GENERAL INSTRUMENT CORPORATION et al

1. This written opinion is the **first** drawn up by this International Preliminary Examining Authority.

2. This opinion contains indications relating to the following items:

I	☒	Basis of the opinion
II	☐	Priority
III	☐	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	☐	Lack of unity of invention
V	☒	Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
VI	☐	Certain document cited
VII	☒	Certain defects in the international application
VIII	☒	Certain observations on the international application

3. The applicant is hereby **invited to reply** to this opinion.

When? See the time limit indicated above. The applicant may, before the expiration of that time limit, request this Authority to grant an extension, see Rule 66.2(d).

How? By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3. For the form and the language of the amendments, see Rules 66.8 and 66.9.

Also: For an additional opportunity to submit amendments, see Rule 66.4. For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4 bis. For an informal communication with the examiner, see Rule 66.6.

If no reply is filed, the international preliminary examination report will be established on the basis of this opinion.

4. The final date by which the international preliminary examination report must be established according to Rule 69.2 is: 30/03/2001.

DOCKETED FOR 11/28/00 Response

Name and mailing address of the international preliminary examining authority:

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Authorized officer / Examiner
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I. Basis of the opinion

1. This opinion has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed".*):

Description, pages:

1-20 as originally filed

Claims, No.:

1-12 as originally filed

Drawings, sheets:

1/8-8/8 as originally filed

2. The amendments have resulted in the cancellation of:

☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

3. This opinion has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1,6,8,12
Inventive step (IS)	Claims	2-5,7,9-11
Industrial applicability (IA)	Claims	

2. Citations and explanations

see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item V

Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following document/s/:

D1: US-A-5 640 697 (ORNDORFF DENNIS LEE) 17 June 1997 (1997-06-17)

D2: DE 43 06 578 A (LOEWE OPTA GMBH) 8 September 1994 (1994-09-08)

D3: WO 84 04637 A (MOTOROLA INC) 22 November 1984 (1984-11-22)

D4: WO 97 23034 A (WHITAKER CORP ;PRESCHUTTI JOSEPH P (US); FLICKINGER STEVEN LEE (US) 26 June 1997 (1997-06-26)

D5: US-A-5 038 404 (MARZ DANIEL) 6 August 1991 (1991-08-06)

1. The document D1 is regarded as being the closest prior art to the subject-matter of claim 12, and discloses (the references in parentheses applying to this document):

A method for receiving an input RF signal and convert-**ing** said input RF signal to a desired RF output signal, the method comprising:

generating a first frequency (38,40) for mixing with said input RF signal to generate a high intermediate frequency signal;

generating a second frequency (44,42) for mixing with said HI-IF signal to generate said desired RF output signal;

controlling (34,36,30) said first and second frequency agile local oscillators to obtain said desired RF output signal;

comparing said first frequency with said second frequency (column 5, lines 50-55, claim 1 and 17 of D1) to determine whether any interfering oscillator difference beat frequencies (ODBFs) exist within the bandwidth of said desired RF output signal; and

adjusting said first and second frequency agile local oscillators such that said first and second frequencies move

said interfering ODBFs outside the bandwidth of said desired RF output signal (column 5, lines 43-48).

Consequently, the subject-matter of independent claim 12 is not new and does not therefore meet the requirements of Article 33(2) of the PCT.

2. **Claim 1** claims a communication module employing the method of claim 12. The device of D1 could be defined to be a communication module. Additionally, all features of claim 1 are shown in D2 (see fig. 1) which is a receiver, which also could be defined to be a communication module. Additionally, all features of claim 1 are shown in D3 (see the figures) which is also a receiver. If the function: "communication module" were better defined with support of the description, this could not support an inventive step. The basic idea which is shown in the application is a general solution of a well known problem. An accordingly amended claim would not involve an inventive step and would not satisfy the criterion set forth in Article 33(3) PCT.

3. **Claim 11** claims a modification of the basic idea of claim 1 and 12. Most of the features of claim 11 are known from D1. The difference of claim 11 over D1 is that the third PLL synthesizer is controlled. This is however a slight modification of the basic idea of the system of D1.
Thus, the subject-matter of claim 11 does not involve an inventive step and does not satisfy the criterion set forth in Article 33(3) PCT.

4. The features of claims 6 and 8 are known form D1. Consequently, the subject-matter of dependent claims 6 and 8 is not new and does not therefore meet the requirements of Article 33(2) of the PCT.
The other dependent claims contain only minor features known from document D1-D5 or well known to the man skilled in the art.
The subject-matter of these claims is accordingly lacking inventive step contrary to Article 33(3), PCT.

Re Item VII
Certain defects in the international application

The features of the claims are not provided with **reference signs placed in parentheses** (Rule 6.2(b) PCT).

Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the documents D1-D3 is not mentioned in the description, nor are these document/s identified therein.

Re Item VIII
Certain observations on the international application

In claim 12, 2nd line "converts" should be replaced by "converting".

Miscellaneous

In order to facilitate the examination of the conformity of the amended application with the requirements of Article 34(2)(b) PCT, **the applicant is requested to clearly identify the amendments carried out, no matter whether they concern amendments by addition, replacement or deletion**, and to indicate the passages of the application as filed on which these amendments are based (see also Rule 66.8(a) PCT).

If the applicant regards it as appropriate these indications could be submitted in handwritten form on a copy of the relevant parts of the application as filed.

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Correspondence with the EPO on PCT Chapter II demands

In order to ensure that your PCT Chapter II demand is dealt with as promptly as possible you are requested to use the enclosed self-adhesive labels with any correspondence relating to the demand sent to the Munich Office.

One of these labels should be affixed to a prominent place in the upper part of the letter or form etc. which you are filing.